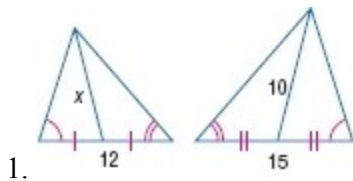


## 7-5 Parts of Similar Triangles

Find  $x$ .



**SOLUTION:**

By AA Similarity, the given two triangles are similar. Additionally, we see the segments marked  $x$  and 10 are medians because they intersect the opposite side at its midpoint.

Theorem 7.10 states that if two triangles are similar, the lengths of corresponding medians are proportional to the lengths of corresponding sides. Therefore,

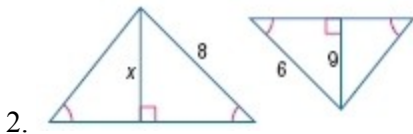
$$\frac{x}{10} = \frac{12}{15}$$

$$15x = 120$$

$$x = 8$$

**ANSWER:**

8



**SOLUTION:**

By AA Similarity, the given two triangles are similar. Additionally, we see the segments marked  $x$  and 10 are medians because they intersect the opposite side at its midpoint.

Theorem 7.8 states that if two triangles are similar, the lengths of corresponding altitudes are proportional to the lengths of corresponding sides. Therefore,

$$\frac{x}{9} = \frac{8}{6}$$

$$6x = 72$$

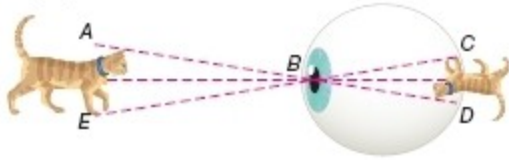
$$x = 12$$

**ANSWER:**

12

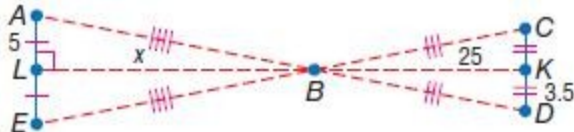
## 7-5 Parts of Similar Triangles

3. **VISION** A cat that is 10 inches tall forms a retinal image that is 7 millimeters tall. If  $\triangle ABE \sim \triangle DBC$  and the distance from the pupil to the retina is 25 millimeters, how far away from your pupil is the cat?



### SOLUTION:

If two triangles are similar, the lengths of corresponding altitudes are proportional to the lengths of corresponding sides. Let the altitude from  $B$  meet  $AE$  at  $L$  and  $CD$  at  $K$ .



Since triangle  $ABE$  and  $DBC$  are similar, triangle  $ALB$  and triangle  $DKB$  are similar.

We know that  $BK = 25$  mm,  $DK = 3.5$  mm and  $AL = 5$  inches. Use the Proportionality Theorem.

$$\frac{BK}{KD} = \frac{LB}{AL}$$

Substitute in given values and solve for  $LB$ .

$$\frac{25}{3.5} = \frac{LB}{5}$$

$$\frac{25}{3.5} = \frac{LB}{5 \times 22}$$

$$\frac{25}{3.5} = \frac{LB}{110}$$

$$3.5LB = 2750$$

$$LB \approx 785.7 \text{ mm}$$

$$LB \approx 35.7 \text{ in.}$$

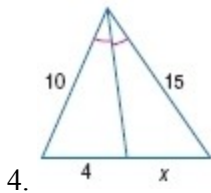
The cat is 35.7 in. away from your pupil.

### ANSWER:

35.7 in.

## 7-5 Parts of Similar Triangles

Find the value of each variable.



**SOLUTION:**

An angle bisector in a triangle separates the opposite side into two segments that are proportional to the lengths of the other two sides.

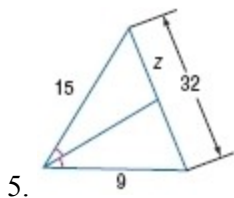
$$\frac{x}{4} = \frac{15}{10}$$

$$10x = 60$$

$$x = 6$$

**ANSWER:**

6



**SOLUTION:**

An angle bisector in a triangle separates the opposite side into two segments that are proportional to the lengths of the other two sides.

$$\frac{z}{32 - z} = \frac{15}{9}$$

$$9z = 480 - 15z$$

$$24z = 480$$

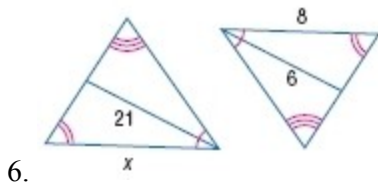
$$z = 20$$

**ANSWER:**

20

## 7-5 Parts of Similar Triangles

Find  $x$ .



**SOLUTION:**

By AA Similarity, the given two triangles are similar. Theorem 7.9 states that if two triangles are similar, the lengths of corresponding angle bisectors are proportional to the lengths of corresponding sides. Therefore,

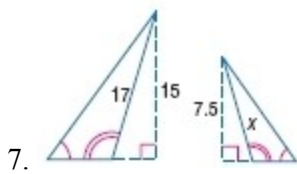
$$\frac{x}{8} = \frac{21}{6}$$

$$6x = 168$$

$$x = 28$$

**ANSWER:**

28



**SOLUTION:**

By AA Similarity, the given two triangles are similar. Theorem 7.8 states that if two triangles are similar, the lengths of corresponding altitudes are proportional to the lengths of corresponding sides. We know that the sides marked 15 and 7.5 are altitudes because they are perpendicular to the side opposite a vertex of the triangle. Therefore,

$$\frac{x}{17} = \frac{7.5}{15}$$

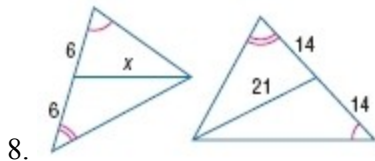
$$15x = 127.5$$

$$x = 8.5$$

**ANSWER:**

8.5

## 7-5 Parts of Similar Triangles



**SOLUTION:**

By AA Similarity, the given two triangles are similar. Theorem 7.10 states that if two triangles are similar, the lengths of corresponding medians are proportional to the lengths of corresponding sides. We know that the segments marked  $x$  and  $21$  are medians because they intersect the opposite side at its midpoint. Therefore,

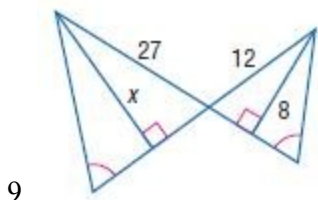
$$\frac{x}{21} = \frac{12}{28}$$

$$28x = 252$$

$$x = 9$$

**ANSWER:**

9



**SOLUTION:**

By AA Similarity, the given two triangles are similar. We know that the segments labeled  $x$  and  $8$  are altitudes because they are perpendicular to the side opposite a vertex. Theorem 7.8 states that if two triangles are similar, the lengths of corresponding altitudes are proportional to the lengths of corresponding sides. Therefore,

$$\frac{x}{8} = \frac{27}{12}$$

$$12x = 216$$

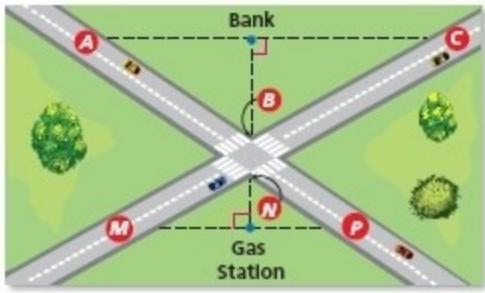
$$x = 18$$

**ANSWER:**

18

## 7-5 Parts of Similar Triangles

10. **ROADWAYS** The intersection of the two roads shown forms two similar triangles. If  $AC$  is 382 feet,  $MP$  is 248 feet, and the gas station is 50 feet from the intersection, how far from the intersection is the bank?



**SOLUTION:**

If two triangles are similar, the lengths of corresponding altitudes are proportional to the lengths of corresponding sides. Let  $x$  be the distance between the intersection and the bank.

$$\frac{\text{The distance from the Bank to point B}}{\text{The distance from the Gas Station to point B}} = \frac{AC}{MP}$$
$$\frac{x}{50} = \frac{382}{248}$$
$$248x = 19100$$
$$x \approx 77$$

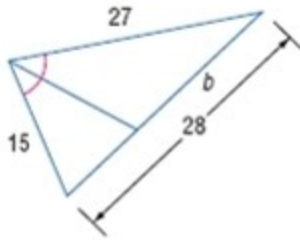
Therefore, the distance between the intersection at point B and the bank is about 77 feet.

**ANSWER:**

about 77 ft

## 7-5 Parts of Similar Triangles

**CCSS SENSE-MAKING** Find the value of each variable.



11.

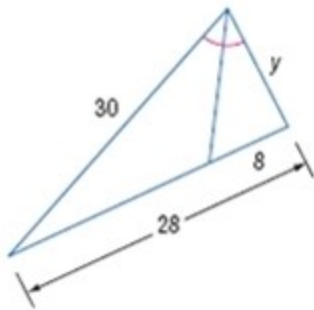
**SOLUTION:**

An angle bisector in a triangle separates the opposite side into two segments that are proportional to the lengths of the other two sides.

$$\begin{aligned}\frac{15}{27} &= \frac{28-b}{b} \\ 15b &= 27(28-b) \\ 15b &= 756 - 27b \\ 42b &= 756 \\ b &= 18\end{aligned}$$

**ANSWER:**

18



12.

**SOLUTION:**

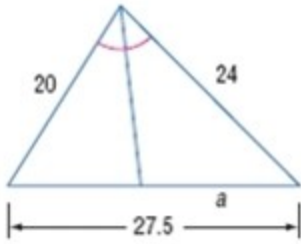
An angle bisector in a triangle separates the opposite side into two segments that are proportional to the lengths of the other two sides.

$$\begin{aligned}\frac{8}{28-8} &= \frac{y}{30} \\ \frac{8}{20} &= \frac{y}{30} \\ 20y &= 240 \\ y &= 12\end{aligned}$$

**ANSWER:**

12

## 7-5 Parts of Similar Triangles



13.

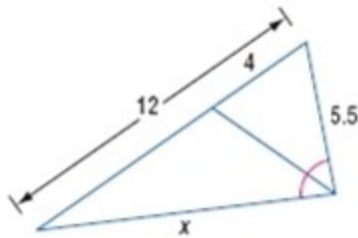
**SOLUTION:**

An angle bisector in a triangle separates the opposite side into two segments that are proportional to the lengths of the other two sides.

$$\begin{aligned}\frac{20}{24} &= \frac{27.5 - a}{a} \\ 20a &= 24(27.5 - a) \\ 20a &= 660 - 24a \\ 44a &= 660 \\ a &= 15\end{aligned}$$

**ANSWER:**

15



14.

**SOLUTION:**

An angle bisector in a triangle separates the opposite side into two segments that are proportional to the lengths of the other two sides.

$$\begin{aligned}\frac{x}{5.5} &= \frac{12 - 4}{4} \\ \frac{x}{5.5} &= \frac{8}{4} \\ 4x &= 44 \\ x &= 11\end{aligned}$$

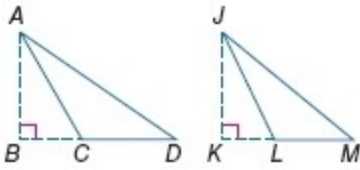
**ANSWER:**

11



## 7-5 Parts of Similar Triangles

15. **ALGEBRA** If  $\overline{AB}$  and  $\overline{JK}$  are altitudes,  $\triangle DAC \sim \triangle MJL$ ,  $AB = 9$ ,  $AD = 4x - 8$ ,  $JK = 21$ , and  $JM = 5x + 3$ , find  $x$ .



**SOLUTION:**

Form a proportion.

$$\frac{AB}{JK} = \frac{AD}{JM}$$

Substitute.

$$\frac{9}{21} = \frac{4x - 8}{5x + 3}$$

Solve for  $x$ .

$$9(5x + 3) = 21(4x - 8)$$

$$45x + 27 = 84x - 168$$

$$45x - 84x = -27 - 168$$

$$-39x = -195$$

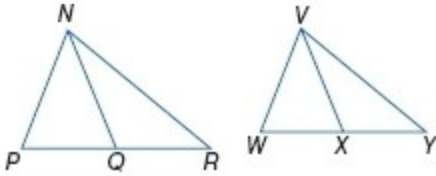
$$x = 5$$

**ANSWER:**

5

## 7-5 Parts of Similar Triangles

16. **ALGEBRA** If  $\overline{NQ}$  and  $\overline{VX}$  are medians,  $\triangle PNR \sim \triangle WVY$ ,  $NQ = 8$ ,  $PR = 12$ ,  $WY = 7x - 1$ , and  $VX = 4x + 2$ , find  $x$ .



**SOLUTION:**

If two triangles are similar, the lengths of corresponding medians are proportional to the lengths of corresponding sides.

$$\frac{NQ}{VX} = \frac{PR}{WY}$$

Substitute.

$$\frac{8}{4x+2} = \frac{12}{7x-1}$$

Solve for  $x$ .

$$8(7x-1) = 12(4x+2)$$

$$56x - 8 = 48x + 24$$

$$8x = 32$$

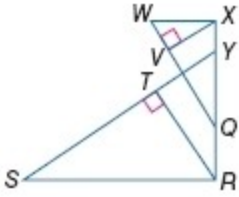
$$x = 4$$

**ANSWER:**

4

## 7-5 Parts of Similar Triangles

17. If  $\triangle SRY \sim \triangle WXQ$ ,  $\overline{RT}$  is an altitude of  $\triangle SRY$ ,  $\overline{XV}$  is an altitude of  $\triangle WXQ$ ,  $RT = 5$ ,  $RQ = 4$ ,  $QY = 6$ , and  $YX = 2$ , find  $XV$ .



**SOLUTION:**

If two triangles are similar, the lengths of corresponding altitudes are proportional to the lengths of corresponding sides.

$$\frac{TR}{VX} = \frac{YR}{XQ}$$

$$\frac{TR}{VX} = \frac{RQ + QY}{XY + YQ}$$

Substitute.

$$\frac{5}{VX} = \frac{10}{8}$$

$$10VX = 40$$

$$VX = 4$$

**ANSWER:**

4

## 7-5 Parts of Similar Triangles

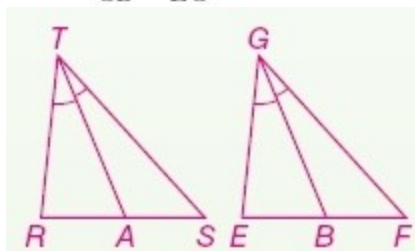
18. **PROOF** Write a paragraph proof of Theorem 7.9.

**SOLUTION:**

Theorem 7.9 states that if two triangles are similar, the lengths of corresponding angle bisectors are proportional to the lengths of corresponding sides. In your proof, since you are given that two triangles are similar, you can use congruent corresponding angle measures to prove that  $\angle R \cong \angle E$ . Then, since  $\angle T$  and  $\angle G$  are congruent and bisected, their halves are also congruent. Therefore, by AA Similarity theorem,  $\triangle RTA \sim \triangle EGB$  and, consequently, corresponding sides are proportional to each other.

Given:  $\triangle RTS \sim \triangle EGF$ ,  $\overline{TA}$  and  $\overline{GB}$  are angle bisectors.

Prove:  $\frac{TA}{GB} = \frac{RT}{EG}$

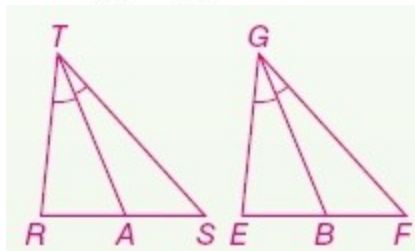


Proof: Because corresponding angles of similar triangles are congruent,  $\angle R \cong \angle E$  and  $\angle RTS \cong \angle EGF$ . Since  $\angle RTS$  and  $\angle EGF$  are bisected, we know that  $\frac{1}{2}m\angle RTS = \frac{1}{2}m\angle EGF$  or  $m\angle RTA = m\angle EGB$ . This makes  $\triangle RTA \sim \triangle EGB$  by AA Similarity. Thus, since corresponding sides are proportional in similar triangles, we can state that  $\frac{TA}{GB} = \frac{RT}{EG}$ .

**ANSWER:**

Given:  $\triangle RTS \sim \triangle EGF$ ,  $\overline{TA}$  and  $\overline{GB}$  are angle bisectors.

Prove:  $\frac{TA}{GB} = \frac{RT}{EG}$



Proof: Because corresponding angles of similar triangles are congruent,  $\angle R \cong \angle E$  and  $\angle RTS \cong \angle EGF$ . Since  $\angle RTS$  and  $\angle EGF$  are bisected, we know that  $\frac{1}{2}m\angle RTS = \frac{1}{2}m\angle EGF$  or  $m\angle RTA = m\angle EGB$ . This makes  $\angle RTA \cong \angle EGB$  and  $\triangle RTA \sim \triangle EGB$  by AA Similarity. Thus,  $\frac{TA}{GB} = \frac{RT}{EG}$ .

19. **PROOF** Write a two-column proof of Theorem 7.10.

**SOLUTION:**

Theorem 7.10 states that if two triangles are similar, the lengths of corresponding medians are proportional to the

## 7-5 Parts of Similar Triangles

lengths of corresponding sides. Since we know that  $\triangle ABC \sim \triangle RST$ , we can use congruent corresponding angles and proportional sides to work towards getting  $\triangle ABD \sim \triangle RSU$ . Since we already have  $\angle B \cong \angle S$  and  $\frac{AB}{RS} = \frac{CB}{TS}$ , we can use the given that  $\overline{AD}$  and  $\overline{RU}$  are medians to prove that,

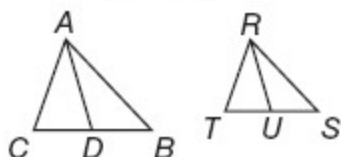
$\frac{AB}{RS} = \frac{DB}{US}$  through segment addition postulate, definition of median, and substitution. Once this is established, you can prove that  $\triangle ABD \sim \triangle RSU$  and, consequently, corresponding parts are proportional in these two triangles.

Given:  $\triangle ABC \sim \triangle RST$

$\overline{AD}$  is a median of  $\triangle ABC$ .

$\overline{RU}$  is a median of  $\triangle RST$ .

Prove:  $\frac{AD}{RU} = \frac{AB}{RS}$



Proof:

Statements (Reasons)

1.  $\triangle ABC \sim \triangle RST$ ;  $\overline{AD}$  is a median of  $\triangle ABC$ ;  $\overline{RU}$  is a median of  $\triangle RST$ . (Given)
2.  $CD = DB$ ;  $TU = US$  (Def. of median)
3.  $\frac{AB}{RS} = \frac{CB}{TS}$  (Def. of  $\sim \Delta s$ )
4.  $CB = CD + DB$ ;  $TS = TU + US$  (Seg. Add. Post.)
5.  $\frac{AB}{RS} = \frac{CD + DB}{TU + US}$  (Subst.)
6.  $\frac{AB}{RS} = \frac{DB + DB}{US + US}$  or  $\frac{2(DB)}{2(US)}$  (Subst.)
7.  $\frac{AB}{RS} = \frac{DB}{US}$  (Subst.)
8.  $\angle B \cong \angle S$  (Def. of  $\sim$  triangles)
9.  $\triangle ABD \sim \triangle RSU$  (SAS Similarity)
10.  $\frac{AD}{RU} = \frac{AB}{RS}$  (Def. of  $\sim \Delta s$ )

**ANSWER:**

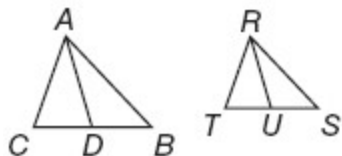
Given:  $\triangle ABC \sim \triangle RST$

$\overline{AD}$  is a median of  $\triangle ABC$ .

$\overline{RU}$  is a median of  $\triangle RST$ .

Prove:  $\frac{AD}{RU} = \frac{AB}{RS}$

## 7-5 Parts of Similar Triangles

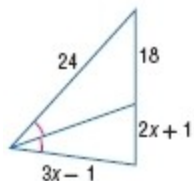


Proof:

Statements (Reasons)

1.  $\triangle ABC \sim \triangle RST$ ;  $\overline{AD}$  is a median of  $\triangle ABC$ ;  $\overline{RU}$  is a median of  $\triangle RST$ . (Given)
2.  $CD = DB$ ;  $TU = US$  (Def. of median)
3.  $\frac{AB}{RS} = \frac{CB}{TS}$  (Def. of  $\sim \Delta s$ )
4.  $CB = CD + DB$ ;  $TS = TU + US$  (Seg. Add. Post.)
5.  $\frac{AB}{RS} = \frac{CD + DB}{TU + US}$  (Subst.)
6.  $\frac{AB}{RS} = \frac{DB + DB}{US + US}$  or  $\frac{2(DB)}{2(US)}$  (Subst.)
7.  $\frac{AB}{RS} = \frac{DB}{US}$  (Subst.)
8.  $\angle B \cong \angle S$  (Def. of  $\sim$  triangles)
9.  $\triangle ABD \sim \triangle RSU$  (SAS Similarity)
10.  $\frac{AD}{RU} = \frac{AB}{RS}$  (Def. of  $\sim \Delta s$ )

**ALGEBRA Find  $x$ .**



20.

**SOLUTION:**

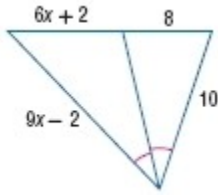
An angle bisector in a triangle separates the opposite side into two segments that are proportional to the lengths of the other two sides.

$$\begin{aligned} \frac{18}{2x+1} &= \frac{24}{3x-1} \\ 18(3x-1) &= 24(2x+1) \\ 54x-18 &= 48x+24 \\ 6x &= 42 \\ x &= 7 \end{aligned}$$

**ANSWER:**

7

## 7-5 Parts of Similar Triangles



21.

**SOLUTION:**

An angle bisector in a triangle separates the opposite side into two segments that are proportional to the lengths of the other two sides.

$$\frac{6x + 2}{8} = \frac{9x - 2}{10}$$

$$10(6x + 2) = 8(9x - 2)$$

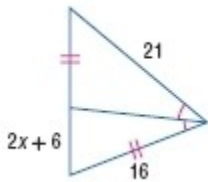
$$60x + 20 = 72x - 16$$

$$12x = 36$$

$$x = 3$$

**ANSWER:**

3



22.

**SOLUTION:**

An angle bisector in a triangle separates the opposite side into two segments that are proportional to the lengths of the other two sides.

$$\frac{2x + 6}{16} = \frac{16}{21}$$

$$21(2x + 6) = 256$$

$$42x + 126 = 256$$

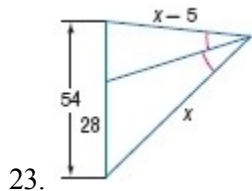
$$42x = 130$$

$$x \approx 3.1$$

**ANSWER:**

3.1

## 7-5 Parts of Similar Triangles



**SOLUTION:**

An angle bisector in a triangle separates the opposite side into two segments that are proportional to the lengths of the other two sides.

$$\frac{x-5}{x} = \frac{54-28}{28}$$

$$\frac{x-5}{x} = \frac{26}{28}$$

$$\frac{x-5}{x} = \frac{13}{14}$$

$$14(x-5) = 13x$$

$$14x - 70 = 13x$$

$$x = 70$$

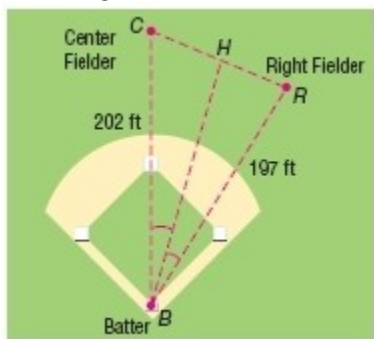
**ANSWER:**

70



## 7-5 Parts of Similar Triangles

24. **SPORTS** Consider the triangle formed by the path between a batter, center fielder, and right fielder as shown. If the batter gets a hit that bisects the triangle at  $\angle B$ , is the center fielder or the right fielder closer to the ball? Explain your reasoning.



**SOLUTION:**

Right fielder; sample answer: According to the Triangle Bisector Theorem, an angle bisector in a triangle separates the opposite side into two segments that are proportional to the lengths of the other two sides. Since the hit bisects

the triangle, the sides opposite the batter are proportional to the other two sides, such as  $\frac{CH}{202} = \frac{RH}{197}$  or  $\frac{CH}{RH} = \frac{BC}{BR}$ .

Substituting,  $\frac{CH}{RH} = \frac{202}{197} = 1.03$ . Since  $\frac{CH}{RH}$  is slightly greater than 1,  $CH$  is slightly longer than  $RH$ .

Therefore, the right fielder is closer to the hit.

**ANSWER:**

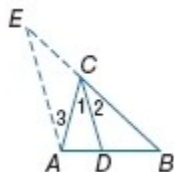
Right fielder; sample answer: Since the hit bisects the triangle, the sides opposite the right angle are proportional to the other two sides, or  $\frac{CH}{RH} = \frac{BC}{BR}$ . Substituting,  $\frac{CH}{RH} = \frac{202}{197} = 1.03$ . Since  $\frac{CH}{RH}$  is slightly greater than 1,  $CH$  is slightly longer than  $RH$ . Therefore, the right fielder is closer to the hit.

**CCSS ARGUMENTS Write a two-column proof.**

25. Theorem 7.11

**Given:**  $\overline{CD}$  bisects  $\angle ACB$ . By construction,  $\overline{AE} \parallel \overline{CD}$ .

**Prove:**  $\frac{AD}{DB} = \frac{AC}{BC}$



**SOLUTION:**

Theorem 7.11 states that an angle bisector in a triangle separates the opposite side into two segments that are proportional to the lengths of the other two sides. Since you have a line ( $\overline{CD}$ ) that is parallel to one side of the triangle and divides the other sides of the triangle into two parts, by the Triangle Proportionality theorem, we know

that  $\frac{AD}{DB} = \frac{EC}{BC}$ . This looks very similar to the conclusion, except we need to replace  $EC$  with  $AC$ . Since  $\overline{CD} \parallel \overline{EA}$ ,

## 7-5 Parts of Similar Triangles

then  $\angle E \cong \angle 2$  and  $\angle 1 \cong \angle 3$ . From the given information, we can also conclude that  $\angle 1 \cong \angle 2$  (How?). Therefore,  $\angle E \cong \angle 3$ . This means that  $\triangle ECA$  is an isosceles triangle and  $\overline{EC} \cong \overline{AC}$ . Now, we can replace EC with AC in  $\frac{AD}{DB} = \frac{EC}{BC}$ .

Proof:

Statements (Reasons)

- $\overline{CD}$  bisects  $\angle ACB$ ; By construction,  $\overline{AE} \parallel \overline{CD}$ . (Given)
- $\frac{AD}{DB} = \frac{EC}{BC}$  ( $\Delta$  Prop. Thm.)
- $\angle 1 \cong \angle 2$  (Def. of Angle Bisector)
- $\angle 3 \cong \angle 1$  (Alt. Int. angle Thm.)
- $\angle 2 \cong \angle E$  (Corr. angle Post.)
- $\angle 3 \cong \angle E$  (Trans. Prop.)
- $\overline{EC} \cong \overline{AC}$  (Conv. of Isos.  $\Delta$  Thm.)
- $EC = AC$  (Def. of  $\cong$  segs.)
- $\frac{AD}{DB} = \frac{AC}{BC}$  (Subst.)

ANSWER:

Proof:

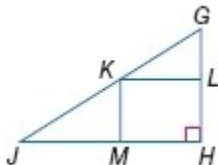
Statements (Reasons)

- $\overline{CD}$  bisects  $\angle ACB$ ; By construction,  $\overline{AE} \parallel \overline{CD}$ . (Given)
- $\frac{AD}{DB} = \frac{EC}{BC}$  ( $\Delta$  Prop. Thm.)
- $\angle 1 \cong \angle 2$  (Def. of Angle Bisector)
- $\angle 3 \cong \angle 1$  (Alt. Int. angle Thm.)
- $\angle 2 \cong \angle E$  (Corr. angle Post.)
- $\angle 3 \cong \angle E$  (Trans. Prop.)
- $\overline{EC} \cong \overline{AC}$  (Conv. of Isos.  $\Delta$  Thm.)
- $EC = AC$  (Def. of  $\cong$  segs.)
- $\frac{AD}{DB} = \frac{AC}{BC}$  (Subst.)

## 7-5 Parts of Similar Triangles

26. **Given:**  $\angle H$  is a right angle.  $L$ ,  $K$ , and  $M$  are midpoints.

**Prove:**  $\angle LKM$  is a right angle.



**SOLUTION:**

This proof is based on the idea that, if you can prove that  $\angle H$ ,  $\angle GLK$ , and  $\angle LKM$  are all congruent to each other and one is a right angle, then they all must be right angles. Think about how to get  $\overline{JH} \parallel \overline{LK}$ ,  $\overline{GH} \parallel \overline{KM}$  using the given information. Then, the angle relationships will follow.

Proof:

Statements (Reasons)

- $\angle H$  is a right angle.  $L$ ,  $K$ , and  $M$  are midpoints. (Given)
- $\overline{JH} \parallel \overline{LK}$ ,  $\overline{GH} \parallel \overline{KM}$  (Midsegment Thm.)
- $\angle H \cong \angle GLK$  (Corr. angles Post.)
- $\angle GLK \cong \angle LKM$  (Alt. Int. angles  $\cong$ )
- $\angle GLK$  is a right angle. (Subst.)
- $\angle LKM$  is a right angle. (Subst.)

**ANSWER:**

Proof:

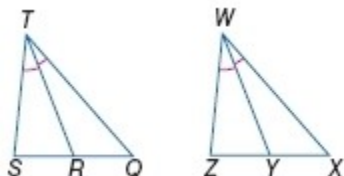
Statements (Reasons)

- $\angle H$  is a right angle.  $L$ ,  $K$ , and  $M$  are midpoints. (Given)
- $\overline{JH} \parallel \overline{LK}$ ,  $\overline{GH} \parallel \overline{KM}$  (Midsegment Thm.)
- $\angle H \cong \angle GLK$  (Corr.  $\angle$ s Post.)
- $\angle GLK \cong \angle LKM$  (Alt. Int.  $\angle$ s  $\cong$ )
- $\angle GLK$  is a right angle. (Subst.)
- $\angle LKM$  is a right angle. (Subst.)

**PROOF Write a two-column proof.**

27. **Given:**  $\triangle QTS \sim \triangle XWZ$ ,  $\overline{TR}$  and  $\overline{WY}$  are angle bisectors.

**Prove:**  $\frac{TR}{WY} = \frac{QT}{XW}$



**SOLUTION:**

This proof is based on the idea that, if you can prove  $\triangle QTR \sim \triangle XWY$ , then you can make a proportional statement regarding corresponding sides. So, since  $\triangle STQ \sim \triangle ZWX$ , we already know that  $\angle Q \cong \angle X$ . Therefore, we just need one more pair of congruent corresponding angles. We are given that  $\overline{TR}$  and  $\overline{WY}$  are angle bisectors so we

## 7-5 Parts of Similar Triangles

can state that  $\angle STR \cong \angle QTR$  and  $\angle ZWY \cong \angle YWX$ . We also know that  $\angle STQ \cong \angle ZWX$ , so you can also prove that their half angles must also be congruent. Then, by AA Similarity, you can prove  $\triangle QTR \sim \triangle XWY$ , and

consequently,  $\frac{TR}{WY} = \frac{QT}{XW}$ .

Proof:

Statements (Reasons)

1.  $\triangle STQ \sim \triangle ZWX$ ,  $\overline{TR}$  and  $\overline{WY}$  are angle bisectors. (Given)
2.  $\angle STQ \cong \angle ZWX$ ,  $\angle Q \cong \angle X$  (Def of  $\sim \Delta$ s)
3.  $\angle STR \cong \angle QTR$ ,  $\angle ZWY \cong \angle YWX$  (Def. angle bisector)
4.  $m\angle STQ = m\angle STR + m\angle QTR$ ,  
 $m\angle ZWX = m\angle ZWY + m\angle XWY$  (Angle Add. Thm.)
5.  $m\angle STQ = 2m\angle QTR$ ,  $m\angle ZWX = 2m\angle XWY$  (Subst.)
6.  $2m\angle QTR = 2m\angle XWY$  (Subst.)
7.  $m\angle QTR = m\angle XWY$  (Div.)
8.  $\angle QTR \cong \angle XWY$  (def of congruent angles)
9.  $\triangle QTR \sim \triangle XWY$  (AA Similarity)
10.  $\frac{TR}{WY} = \frac{QT}{XW}$  (Def of  $\sim \Delta$ s)

**ANSWER:**

Proof:

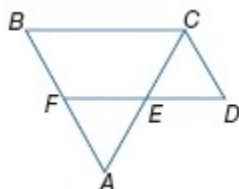
Statements (Reasons)

1.  $\triangle STQ \sim \triangle ZWX$ ,  $\overline{TR}$  and  $\overline{WY}$  are angle bisectors. (Given)
2.  $\angle STQ \cong \angle ZWX$ ,  $\angle Q \cong \angle X$  (Def of  $\sim \Delta$ s)
3.  $\angle STR \cong \angle QTR$ ,  $\angle ZWY \cong \angle YWX$  (Def. angle bisector)
4.  $m\angle STQ = m\angle STR + m\angle QTR$ ,  
 $m\angle ZWX = m\angle ZWY + m\angle XWY$  (Angle Add. Thm.)
5.  $m\angle STQ = 2m\angle QTR$ ,  $m\angle ZWX = 2m\angle XWY$  (Subst.)
6.  $2m\angle QTR = 2m\angle XWY$  (Subst.)
7.  $m\angle QTR = m\angle XWY$  (Div.)
8.  $\angle QTR \cong \angle XWY$  (def of congruent angles)
9.  $\triangle QTR \sim \triangle XWY$  (AA Similarity)
10.  $\frac{TR}{WY} = \frac{QT}{XW}$  (Def of  $\sim \Delta$ s)

## 7-5 Parts of Similar Triangles

28. **Given:**  $\overline{FD} \parallel \overline{BC}$ ,  $\overline{BF} \parallel \overline{CD}$ ,  $\overline{AC}$  bisects  $\angle C$ .

**Prove:**  $\frac{DE}{EC} = \frac{BA}{AC}$



**SOLUTION:**

This proof can be solved by finding two pairs of congruent corresponding angles in  $\triangle DEC$  and  $\triangle BAC$ , thereby proving them similar. Once they are similar, you can prove that any pair of corresponding sides are congruent. Use the given parallel lines to get Alternate Interior angles and corresponding angles congruent. Remember, from the given information, you also know that  $\angle BCE \cong \angle DCE$ . So put all your statements together to get two pairs of congruent angles in  $\triangle DEC$  and  $\triangle BAC$ .

Proof:

Statements (Reasons)

1.  $\overline{FD} \parallel \overline{BC}$ ,  $\overline{BF} \parallel \overline{CD}$ ,  $\overline{AC}$  bisects  $\angle BCD$ . (Given)
2.  $\angle BCE \cong \angle DCE$  (Def.  $\angle$  bisector)
3.  $\angle BCE \cong \angle AEF$  (Corr.  $\angle$ s Post.)
4.  $\angle AEF \cong \angle DEC$  (Vert.  $\angle$ s are  $\cong$ )
5.  $\angle BCE \cong \angle DEC$  (Trans. Prop.)
6.  $\angle BAC \cong \angle DCE$  (Alt. Int  $\angle$ s Thm.)
7.  $\triangle DEC \sim \triangle BAC$  (AA Similarity)
8.  $\frac{DE}{EC} = \frac{BA}{AC}$  (Def of  $\sim \Delta$ s)

**ANSWER:**

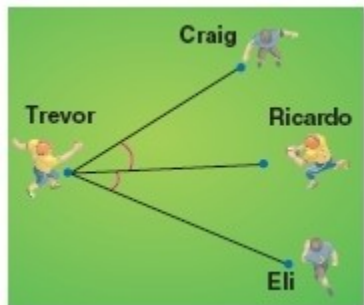
Proof:

Statements (Reasons)

1.  $\overline{FD} \parallel \overline{BC}$ ,  $\overline{BF} \parallel \overline{CD}$ ,  $\overline{AC}$  bisects  $\angle BCD$ . (Given)
2.  $\angle BCE \cong \angle DCE$  (Def.  $\angle$  bisector)
3.  $\angle BCE \cong \angle AEF$  (Corr.  $\angle$ s Post.)
4.  $\angle AEF \cong \angle DEC$  (Vert.  $\angle$ s are  $\cong$ )
5.  $\angle BCE \cong \angle DEC$  (Trans. Prop.)
6.  $\angle BAC \cong \angle DCE$  (Alt. Int  $\angle$ s Thm.)
7.  $\triangle DEC \sim \triangle BAC$  (AA Similarity)
8.  $\frac{DE}{EC} = \frac{BA}{AC}$  (Def of  $\sim \Delta$ s)

## 7-5 Parts of Similar Triangles

29. **SPORTS** During football practice, Trevor threw a pass to Ricardo as shown below. If Eli is farther from Trevor when he completes the pass to Ricardo and Craig and Eli move at the same speed, who will reach Ricardo to tackle him first?



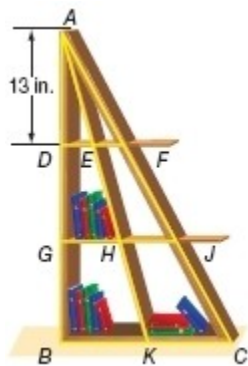
**SOLUTION:**

Craig; According to the Triangle Bisector Theorem, an angle bisector in a triangle separates the opposite side into two segments that are proportional to the lengths of the other two sides. Since the pass bisects the triangle, the sides opposite Trevor are proportional to the distances between Trevor (T) and defenders (Craig (C) and Eli (E)), such as  $\frac{CR}{CT} = \frac{RE}{ET}$ . Since Craig is closer to Trevor, then he is proportionally closer to Ricardo (R).

**ANSWER:**

Craig

30. **SHELVING** In the triangular bookshelf shown, the distance between each of the shelves is 13 inches and  $\overline{AK}$  is a median of  $\triangle ABC$ . If  $EF$  is  $3\frac{1}{3}$  inches, what is  $BK$ ?



**SOLUTION:**

Since  $\angle ADF$  and  $\angle ABC$  are congruent (assuming the shelves are parallel to each other) and  $\angle DAF \cong \angle BAF$ , we know  $\triangle ABC \sim \triangle ADF$ , by AA Similarity. Since we know that  $DE = EF$  and  $BK = KC$ , we can form a proportion of corresponding sides:

$$\frac{AD}{DF} = \frac{AB}{BC}$$

Since  $AB = AD + DG + GH$ ,  $DF = DE + EF$ , and  $BC = BK + KC$ , then we can substitute these values in the proportion as shown:

$$\frac{AD}{DE + EF} = \frac{AD + DG + GB}{BK + KC}$$

## 7-5 Parts of Similar Triangles

Substitute in given values and solve for BK:

$$\frac{13}{3\frac{1}{3} + 3\frac{1}{3}} = \frac{13 + 13 + 13}{BK + BK}$$
$$\frac{13}{6\frac{2}{3}} = \frac{39}{2BK}$$

$$26BK = 39\left(6\frac{2}{3}\right)$$

$$26BK = 39\left(\frac{20}{3}\right)$$

$$26BK = \frac{780}{3}$$

$$BK = \frac{780}{3} \cdot \frac{1}{26}$$

$$BK = \frac{780}{78} = 10$$

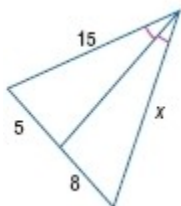
So,  $BK = 10$  in..

**ANSWER:**

10 in.

31. **ERROR ANALYSIS** Chun and Traci are determining the value of  $x$  in the figure. Chun says to find  $x$ , solve the proportion  $\frac{5}{8} = \frac{15}{x}$ , but Traci says to find  $x$ , the proportion  $\frac{5}{x} = \frac{8}{15}$  should be solved. Is either of them correct?

Explain.



**SOLUTION:**

Chun; The Triangle Angle Bisector theorem states that an angle bisector in a triangle separates the opposite side into two segments that are proportional to the lengths of the other two sides. So, a correct proportion would be  $\frac{5}{15} = \frac{8}{x}$ , or as Chun said  $\frac{5}{8} = \frac{15}{x}$ . Traci would have been correct, if the triangles were also similar to each other.

**ANSWER:**

Chun; by the Angle Bisector Theorem, the correct proportion is  $\frac{5}{8} = \frac{15}{x}$ .

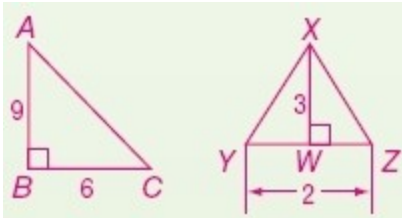
## 7-5 Parts of Similar Triangles

32. **CCSS ARGUMENTS** Find a counterexample to the following statement. Explain.

*If the measure of an altitude and side of a triangle are proportional to the corresponding altitude and corresponding side of another triangle, then the triangles are similar.*

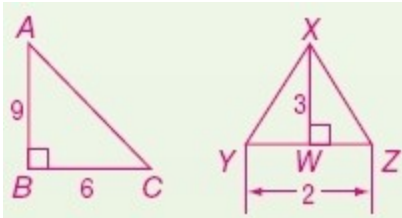
**SOLUTION:**

When choosing triangles that are a counterexample to this statement, choose a right triangle and a non-right triangle. In this way, they will both have an altitude but cannot be similar.



$$\frac{AB}{BC} = \frac{XW}{YZ}, \text{ but } \triangle ABC \not\sim \triangle XYZ .$$

**ANSWER:**

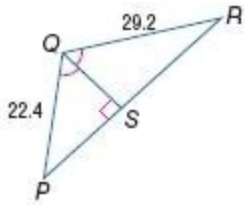


$$\frac{AB}{BC} = \frac{XW}{YZ}, \text{ but } \triangle ABC \not\sim \triangle XYZ .$$



## 7-5 Parts of Similar Triangles

33. **CHALLENGE** The perimeter of  $\triangle PQR$  is 94 units.  $\overline{QS}$  bisects  $\angle PQR$ . Find  $PS$  and  $RS$ .



**SOLUTION:**

The perimeter of triangle  $PQR = 94$ .

We know that  $PQ + QR + PR = 94$ .

Substitute given values and solve for PR:

$$22.4 + 29.2 + PR = 94$$

$$51.6 + PR = 94$$

$$PR = 42.4$$

Form a proportion using similar triangles  $\triangle PSQ$  and  $\triangle SRQ$  and substitute given values:

$$\frac{PS}{22.4} = \frac{SR}{29.2}$$

$$\frac{PS}{22.4} = \frac{42.4 - PS}{29.2}$$

$$29.2PS = 949.76 - 22.4PS$$

$$51.6PS = 949.76$$

$$PS \approx 18.4$$

Since  $PS$  is about 18.4,  $RS$  is about  $42.4 - 18.4$  or 24.

**ANSWER:**

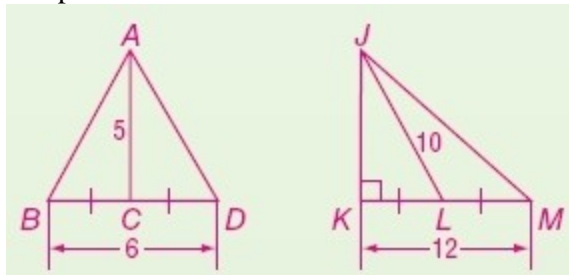
$$PS = 18.4, RS = 24$$

## 7-5 Parts of Similar Triangles

34. **OPEN ENDED** Draw two triangles so that the measures of corresponding medians and a corresponding side are proportional, but the triangles are not similar.

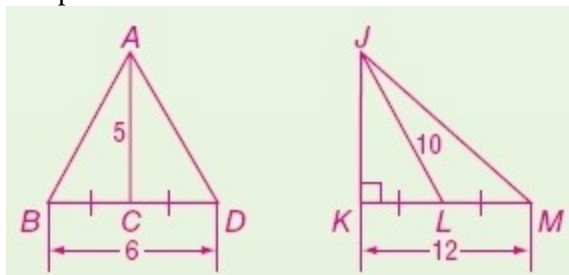
**SOLUTION:**

Sample answer:



**ANSWER:**

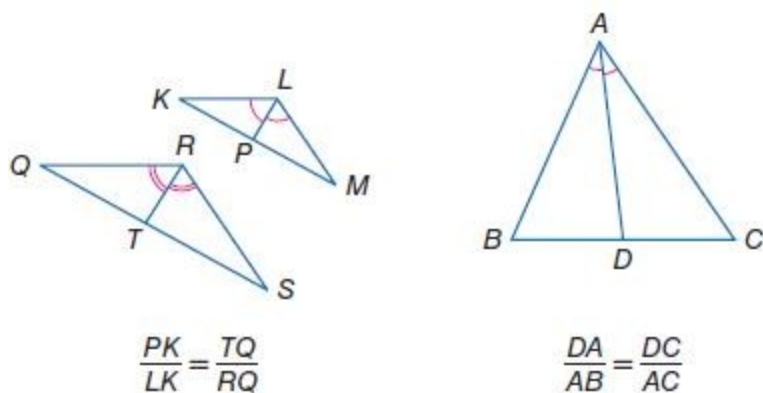
Sample answer:



35. **WRITING IN MATH** Compare and contrast Theorem 7.9 and the Triangle Angle Bisector Theorem.

**SOLUTION:**

Both theorems have a segment that bisects an angle and has proportionate ratios. The Triangle Angle Bisector Theorem pertains to one triangle, while Theorem 7.9 pertains to similar triangles. Unlike the Triangle Angle Bisector Theorem, which separates the opposite side into segments that have the same ratio as the other two sides, Theorem 7.9 relates the angle bisector to the measures of the sides.



**ANSWER:**

Both theorems have a segment that bisects an angle and has proportionate ratios. The Triangle Angle Bisector Theorem pertains to one triangle, while Theorem 7.9 pertains to similar triangles. Unlike the Triangle Angle Bisector Theorem, which separates the opposite side into segments that have the same ratio as the other two sides, Theorem 7.9 relates the angle bisector to the measures of the sides.

## 7-5 Parts of Similar Triangles

36. **ALGEBRA** Which shows 0.00234 written in scientific notation?

- A  $2.34 \times 10^5$
- B  $2.34 \times 10^3$
- C  $2.34 \times 10^{-2}$
- D  $2.34 \times 10^{-3}$

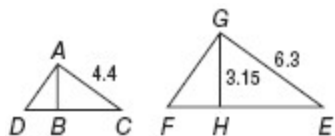
**SOLUTION:**

To write 0.00234 in scientific notation, we have to move the decimal point three places to the right, and compensate by multiplying by  $10^{-3}$ . So, the correct answer is D.

**ANSWER:**

D

37. **SHORT RESPONSE** In the figures below,  $\overline{AB} \perp \overline{DC}$  and  $\overline{GH} \perp \overline{FE}$ .



If  $\triangle ACD \sim \triangle GEF$ , find  $AB$ .

**SOLUTION:**

If two triangles are similar, the lengths of corresponding altitudes are proportional to the lengths of corresponding sides.

$$\begin{aligned}\frac{AB}{GH} &= \frac{AC}{GE} \\ \frac{AB}{3.15} &= \frac{4.4}{6.3} \\ AB &= 2.2\end{aligned}$$

**ANSWER:**

2.2

38. Quadrilateral  $HJKL$  is a parallelogram. If the diagonals are perpendicular, which statement must be true?

- F Quadrilateral  $HJKL$  is a square.
- G Quadrilateral  $HJKL$  is a rectangle.
- H Quadrilateral  $HJKL$  is a rhombus.
- J Quadrilateral  $HJKL$  is an isosceles trapezoid.

**SOLUTION:**

If the diagonals of a parallelogram are perpendicular, then it must be a rhombus, and may or may not be a square.

**ANSWER:**

H

## 7-5 Parts of Similar Triangles

39. **SAT/ACT** The sum of three numbers is 180. Two of the numbers are the same, and each of them is one third of the greatest number. What is the least number?

- A 15
- B 30
- C 36
- D 45
- E 60

**SOLUTION:**

Let  $x$  be the least number.

Form an equation for the given situation.

$$x + x + 3x = 180$$

$$5x = 180$$

$$x = 36$$

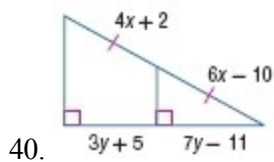
So, the least number is C.

The correct choice is C.

**ANSWER:**

C

**ALGEBRA** Find  $x$  and  $y$ .



**SOLUTION:**

We can prove that the small right triangle and the big right triangle are similar because of AA Similarity.

We are given that  $4x + 2 = 6x - 10$ . Solve for  $x$ :

$$4x + 2 = 6x - 10$$

$$2x = 12$$

$$x = 6$$

By Corollary 7.2,  $7y - 11 = 3y + 5$ . Solve for  $y$ .

$$7y - 11 = 3y + 5$$

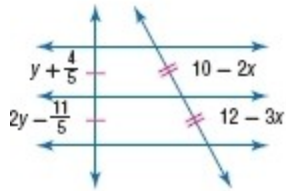
$$4y = 16$$

$$y = 4$$

**ANSWER:**

$x=6; y=4$

## 7-5 Parts of Similar Triangles



41.

**SOLUTION:**

We are given that  $10 - 2x = 12 - 3x$  and  $y + \frac{4}{5} = 2y - \frac{11}{5}$ .

Solve for  $x$ .

$$\begin{aligned}10 - 2x &= 12 - 3x \\ -2 &= -x \\ x &= 2\end{aligned}$$

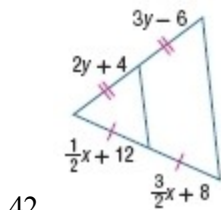
Solve for  $y$ .

$$\begin{aligned}y + \frac{4}{5} &= 2y - \frac{11}{5} \\ -y &= -\frac{15}{5} \\ y &= 3\end{aligned}$$

**ANSWER:**

$$x = 2; y = 3$$

## 7-5 Parts of Similar Triangles



**SOLUTION:**

We are given that  $\frac{1}{2}x + 12 = \frac{3}{2}x + 8$  and  $2y + 4 = 3y - 6$ .

Solve for  $x$ .

$$\frac{1}{2}x + 12 = \frac{3}{2}x + 8$$

$$\frac{1}{2}x - \frac{3}{2}x = 8 - 12$$

$$-x = -4$$

$$x = 4$$

Solve for  $y$ .

$$2y + 4 = 3y - 6$$

$$-y = -10$$

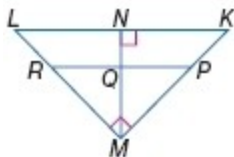
$$y = 10$$

**ANSWER:**

$$x = 4; y = 10$$

**Find the indicated measure(s).**

43. If  $\overline{PR} \parallel \overline{KL}$ ,  $KN = 9$ ,  $LN = 16$ ,  $PM = 2(KP)$ , find  $KP$ ,  $KM$ ,  $MR$ ,  $ML$ ,  $MN$ , and  $PR$ .



**SOLUTION:**

We can prove that  $\triangle LMK \sim \triangle MNK$ , by AA Similarity.

Also, since  $PM = 2(KP)$ , then  $KM = KP + PM = KP + 2(KP) = 3(KP)$ .

Write a proportion and solve for  $KP$ :

## 7-5 Parts of Similar Triangles

$$\frac{MK}{LK} = \frac{NK}{MK}$$
$$\frac{3(KP)}{25} = \frac{9}{3(KP)}$$
$$9(KP)^2 = 225$$
$$(KP)^2 = 25$$
$$KP = 5$$

So,  $KP=5$  and  $KM=3(5)=15$ .

To find RP, we can use the similar triangles  $\triangle LMK \sim \triangle RMP$  (AA Similarity) to write the proportion:

$$\frac{MK}{LK} = \frac{PM}{RP}$$
$$\frac{15}{25} = \frac{10}{RP}$$
$$15RP = 250$$
$$RP = 16\frac{2}{3}$$

Use the Pythagorean Theorem to find LM:

$$LM^2 + MK^2 = LK^2$$
$$LM^2 + 15^2 = 25^2$$
$$LM^2 + 225 = 625$$
$$LM^2 = 400$$
$$LM = 20$$

Finally, we can set up a proportion using similar triangles  $\triangle LMK \sim \triangle MNK$  to find MN:

$$\frac{LM}{MK} = \frac{MK}{NK}$$
$$\frac{20}{15} = \frac{MK}{9}$$
$$180 = 15MK$$
$$12 = MN$$

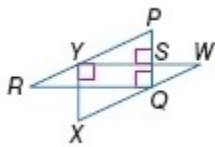
So,  $KP = 5$ ,  $KM = 15$ ,  $MR = 13\frac{1}{3}$ ,  $ML = 20$ ,  $MN = 12$ ,  $PR = 16\frac{2}{3}$

**ANSWER:**

$$KP = 5, KM = 15, MR = 13\frac{1}{3}, ML = 20, MN = 12, PR = 16\frac{2}{3}$$

## 7-5 Parts of Similar Triangles

44. If  $\overline{PR} \parallel \overline{WX}$ ,  $WX = 10$ ,  $XY = 6$ ,  $WY = 8$ ,  $RY = 5$ , and  $PS = 3$ , find  $PY$ ,  $SY$ , and  $PQ$ .



**SOLUTION:**

Since  $\angle PSY$ ,  $\angle PQR$ , and  $\angle WYX$  are right angles, then we know that they are congruent. Also,  $\angle PYS \cong \angle WYX$  (Alternate interior angles theorem) and  $\overline{YW} \parallel \overline{RQ}$  (Converse of corresponding angles theorem). Therefore, we can use similar triangles and parallel lines to write proportional statements:

Since  $\triangle WYX \sim \triangle YSP$  (AA Similarity), we can write proportions to find  $SY$  and  $PY$ :

$$\frac{WY}{YX} = \frac{SY}{SP} \quad \frac{WX}{YX} = \frac{PY}{SP}$$

$$\frac{8}{6} = \frac{SY}{3} \quad \frac{10}{6} = \frac{PY}{3}$$

$$24 = 6SY \quad 30 = 6PY$$

$$4 = SY \quad 5 = PY$$

Since  $\overline{YW} \parallel \overline{RQ}$ , then we can write a proportion concerning the sides of  $\triangle PRQ$ , using the Triangle Proportion Theorem:

$$\frac{PY}{YR} = \frac{PS}{SQ}$$

$$\frac{5}{5} = \frac{3}{SQ}$$

$$15 = 5SQ$$

$$3 = SQ$$

Since  $PQ = PS + SQ$ , then  $PQ = 3 + 3 = 6$  units.

Therefore,  $PY = 5$ ,  $SY = 4$ ,  $PQ = 6$

**ANSWER:**

$$PY = 5, SY = 4, PQ = 6$$



## 7-5 Parts of Similar Triangles

45. **GEESE** A flock of geese flies in formation. Prove that  $\triangle EFG \cong \triangle HFG$  if  $\overline{EF} \cong \overline{HF}$  and that  $G$  is the midpoint of  $\overline{EH}$ .

Refer to Page 508.

**SOLUTION:**

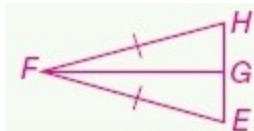
To prove that triangles are congruent, you must use one of the congruent triangle postulates or theorems, like SAS, AAS, ASA, SSS, or HL. Since  $G$  is the midpoint of  $\overline{EH}$ , we know that makes  $\overline{EG} \cong \overline{GH}$ . To determine which one to use for this proof, mark the given relationships on your figure.

Given:  $\overline{EF} \cong \overline{HF}$

$G$  is the midpoint of  $\overline{EH}$ .

Prove:  $\triangle EFG \cong \triangle HFG$

Proof:



Statements (Reasons)

1.  $\overline{EF} \cong \overline{HF}$ ;  $G$  is the midpoint of  $\overline{EH}$ . (Given)
2.  $\overline{EG} \cong \overline{GH}$  (Def. of midpoint)
3.  $\overline{FG} \cong \overline{FG}$  (Reflexive Prop.)
4.  $\triangle EFG \cong \triangle HFG$  (SSS)

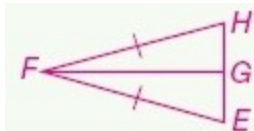
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Given:  $\overline{EF} \cong \overline{HF}$

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## 7-5 Parts of Similar Triangles

**Find the distance between each pair of points.**

46.  $E(-3, -2), F(5, 8)$

**SOLUTION:**

Use the distance formula.

$$\begin{aligned}EF &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\&= \sqrt{(5 - (-3))^2 + (8 - (-2))^2} \\&= \sqrt{(8)^2 + (10)^2} \\&= \sqrt{64 + 100} \\&= \sqrt{164} \\&\approx 12.8\end{aligned}$$

**ANSWER:**

$$\sqrt{164} \approx 12.8$$

47.  $A(2, 3), B(5, 7)$

**SOLUTION:**

Use the distance formula.

$$\begin{aligned}AB &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\&= \sqrt{(5 - 2)^2 + (7 - 3)^2} \\&= \sqrt{(3)^2 + (4)^2} \\&= \sqrt{9 + 16} \\&= \sqrt{25} \\&= 5\end{aligned}$$

**ANSWER:**

$$5$$

## 7-5 Parts of Similar Triangles

48.  $C(-2, 0), D(6, 4)$

**SOLUTION:**

Use the distance formula.

$$\begin{aligned} CD &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\ &= \sqrt{(6 - (-2))^2 + (4 - 0)^2} \\ &= \sqrt{(8)^2 + (4)^2} \\ &= \sqrt{64 + 16} \\ &= \sqrt{80} \\ &\approx 8.9 \end{aligned}$$

**ANSWER:**

$$\sqrt{80} \approx 8.9$$

49.  $W(7, 3), Z(-4, -1)$

**SOLUTION:**

Use the distance formula.

$$\begin{aligned} WZ &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\ &= \sqrt{(-4 - 7)^2 + (-1 - 3)^2} \\ &= \sqrt{(-11)^2 + (-4)^2} \\ &= \sqrt{121 + 16} \\ &= \sqrt{137} \\ &\approx 11.7 \end{aligned}$$

**ANSWER:**

$$\sqrt{137} \approx 11.7$$

## 7-5 Parts of Similar Triangles

50.  $J(-4, -5), K(2, 9)$

**SOLUTION:**

Use the distance formula.

$$\begin{aligned} JK &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\ &= \sqrt{(2 - (-4))^2 + (9 - (-5))^2} \\ &= \sqrt{(6)^2 + (14)^2} \\ &= \sqrt{36 + 196} \\ &= \sqrt{232} \\ &\approx 15.2 \end{aligned}$$

**ANSWER:**

$$\sqrt{232} \approx 15.2$$

51.  $R(-6, 10), S(8, -2)$

**SOLUTION:**

Use the distance formula.

$$\begin{aligned} RS &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\ &= \sqrt{(8 - (-6))^2 + (-2 - 10)^2} \\ &= \sqrt{(14)^2 + (-12)^2} \\ &= \sqrt{196 + 144} \\ &= \sqrt{340} \\ &\approx 18.4 \end{aligned}$$

**ANSWER:**

$$\sqrt{340} \approx 18.4$$