Warm Up

Convert each measurement.

1. 6 ft 3 in. to inches 75 in.

2. 5 m 38 cm to centimeters 538 cm

Find the perimeter and area of each polygon.

3. square with side length 13 cm

$P = 52$ cm, $A = 169$ cm^2

4. rectangle with length 5.8 m and width 2.5 m

$P = 16.6$ m, $A = 14.5$ m^2

7-5 Using Proportional Relationships

Objectives

Use ratios to make indirect measurements.

Use scale drawings to solve problems.

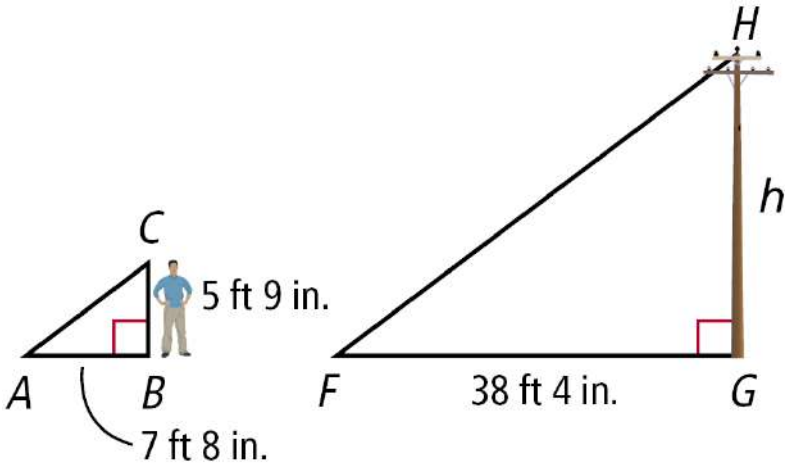
Indirect measurement is any method that uses formulas, similar figures, and/or proportions to measure an object.

Helpful Hint

Whenever dimensions are given in both feet and inches, you must convert them to either feet or inches before doing any calculations.

Example 1: Measurement Application

Tyler wants to find the height of a telephone pole. He measured the pole's shadow and his own shadow and then made a diagram. What is the height *h* of the pole?



Example 1 Continued

Step 1 Convert the measurements to inches.

AB = 7 ft 8 in. = (7 • 12) in. + 8 in. = 92 in.

BC = 5 ft 9 in. = (5 • 12) in. + 9 in. = 69 in.

FG = 38 ft 4 in. = (38 • 12) in. + 4 in. = 460 in.

Step 2 Find similar triangles.

Because the sun's rays are parallel, $\angle A \cong \angle F$. Therefore $\Delta ABC \sim \Delta FGH$ by AA $\sim$.

Example 1 Continued

Step 3 Find h.

Corr. sides are proportional.

$$\frac{BC}{GH} = \frac{AB}{FG}$$

Substitute 69 for BC, h for GH, 92 for AB, and 460 for FG.

$$\frac{69}{h} = \frac{92}{460}$$

Cross Products Prop.

$$92h = 69 \cdot 460$$

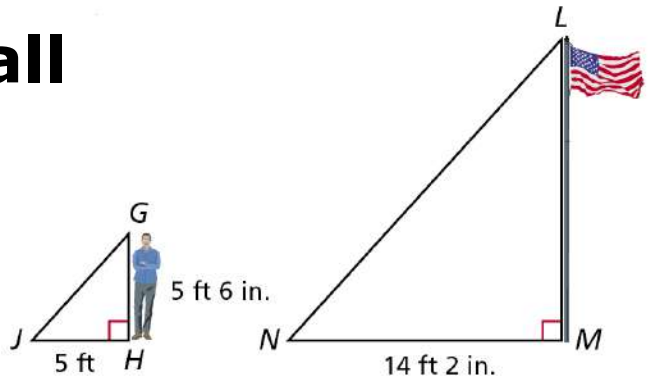
Divide both sides by 92.

$$h = 345$$

The height h of the pole is 345 inches, or 28 feet 9 inches.

Check It Out! Example 1

A student who is 5 ft 6 in. tall measured shadows to find the height *LM* of a flagpole. What is *LM*?



Step 1 Convert the measurements to inches.

GH = 5 ft 6 in. = (5 • 12) in. + 6 in. = 66 in.

JH = 5 ft = (5 • 12) in. = 60 in.

NM = 14 ft 2 in. = (14 • 12) in. + 2 in. = 170 in.

Check It Out! Example 1 Continued

Step 2 Find similar triangles.

Because the sun's rays are parallel, $\angle L \cong \angle G$. Therefore $\Delta JGH \sim \Delta NLM$ by AA ~.

Step 3 Find h.

$$\frac{GH}{JH} = \frac{LM}{MN}$$ *Corr. sides are proportional.*

$$\frac{66}{60} = \frac{h}{170}$$ *Substitute 66 for BC, h for LM, 60 for JH, and 170 for MN.*

$60(h) = 66 \cdot 170$ *Cross Products Prop.*

$h = 187$ *Divide both sides by 60.*

The height of the flagpole is 187 in., or 15 ft. 7 in.

7-5 Using Proportional Relationships

A **scale drawing** represents an object as smaller than or larger than its actual size.

The drawing's **scale** is the ratio of any length in the drawing to the corresponding actual length.

Remember!

A proportion may compare measurements that have different units.

Example 2: Solving for a Dimension

On a Wisconsin road map, Kristin measured a distance of $11\frac{1}{8}$ in. from Madison to Wausau. The scale of this map is 1inch:13 miles. What is the actual distance between Madison and Wausau to the nearest mile?

Example 2 Continued

To find the actual distance x write a proportion comparing the map distance to the actual distance.

$$\frac{11\frac{1}{8}}{x} = \frac{1}{13}$$

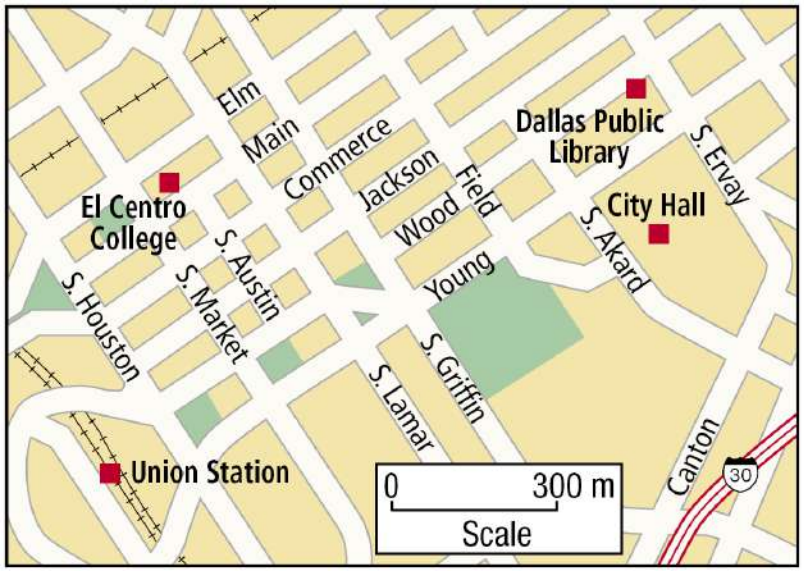
$$1x = 11\frac{1}{8}(13) \quad \textit{Cross Products Prop.}$$

$$x \approx 145 \quad \textit{Simplify.}$$

The actual distance is 145 miles, to the nearest mile.

Check It Out! Example 2

Find the actual distance between City Hall and El Centro College.



Check It Out! Example 2 Continued

To find the actual distance x write a proportion comparing the map distance to the actual distance.

$$\frac{3}{x} = \frac{1}{300}$$

$1x = 3(300)$ *Cross Products Prop.*

$x \approx 900$ *Simplify.*

The actual distance is 900 meters, or 0.9 km.

Check It Out! Example 3

The rectangular central chamber of the Lincoln Memorial is 74 ft long and 60 ft wide. Make a scale drawing of the floor of the chamber using a scale of 1 in.:20 ft.

Check It Out! Example 3 Continued

Set up proportions to find the length ℓ and width w of the scale drawing.

$$\frac{\ell}{74} = \frac{1}{20}$$

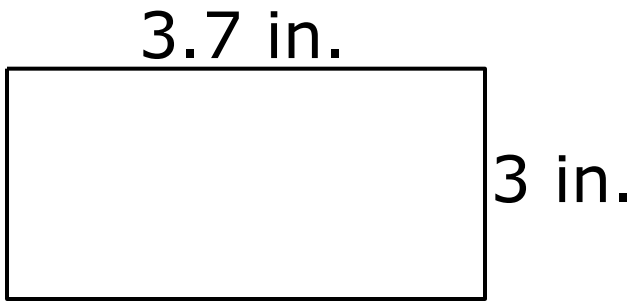
$$20\ell = 74$$

$$\ell = 3.7 \text{ in.}$$

$$\frac{w}{60} = \frac{1}{20}$$

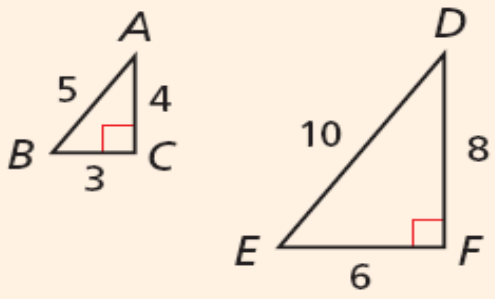
$$20w = 60$$

$$w = 3 \text{ in}$$



7-5 Using Proportional Relationships

Similar Triangles — Similarity, Perimeter, and Area Ratios

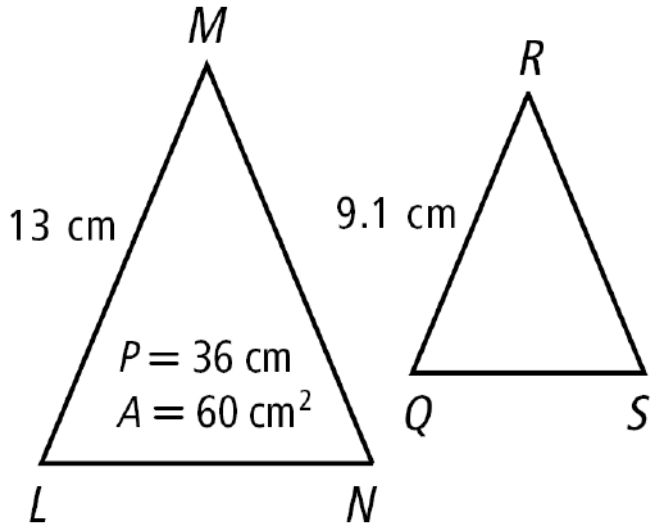
STATEMENT	RATIO
$\triangle ABC \sim \triangle DEF$ 	Similarity ratio: $\frac{AB}{DE} = \frac{AC}{DF} = \frac{BC}{EF} = \frac{1}{2}$ Perimeter ratio: $\frac{\text{perimeter } \triangle ABC}{\text{perimeter } \triangle DEF} = \frac{12}{24} = \frac{1}{2}$ Area ratio: $\frac{\text{area } \triangle ABC}{\text{area } \triangle DEF} = \frac{6}{24} = \frac{1}{4} = \left(\frac{1}{2}\right)^2$

Theorem 7-5-1 — Proportional Perimeters and Areas Theorem

If the similarity ratio of two similar figures is $\frac{a}{b}$, then the ratio of their perimeters is $\frac{a}{b}$, and the ratio of their areas is $\frac{a^2}{b^2}$, or $\left(\frac{a}{b}\right)^2$.

Example 4: Using Ratios to Find Perimeters and Areas

Given that $\Delta LMN : \Delta QRT$, find the perimeter P and area A of ΔQRS.



The similarity ratio of ΔLMN to ΔQRS is $\frac{13}{9.1}$.

Example 4 Continued

Perimeter

$$\frac{36}{P} = \frac{13}{9.1}$$

$13P = 36(9.1)$

$13P = 327.6$

$P = 25.2$

Area

$$\frac{60}{A} = \left(\frac{13}{9.1}\right)^2$$

$169A = (82.81)(60)$

$169A = 4968.6$

$A = 29.4 \text{ cm}^2$

The perimeter of ΔQRS is 25.2 cm, and the area is 29.4 cm^2.

Check It Out! Example 4

$\Delta ABC \sim \Delta DEF$, $BC = 4$ mm, and $EF = 12$ mm. If $P = 42$ mm and $A = 96$ mm^2 for ΔDEF, find the perimeter and area of ΔABC.

Perimeter

$$\frac{42}{P} = \frac{12}{4}$$

$$12P = 42(4)$$

$$P = 14 \text{ mm}$$

Area

$$\frac{96}{A} = \left(\frac{12}{4}\right)^2$$

$$12^2A = (4)^2(96)$$

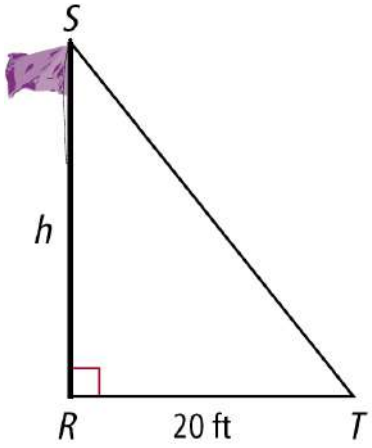
$$A = 10\frac{2}{3} \text{ mm}^2$$

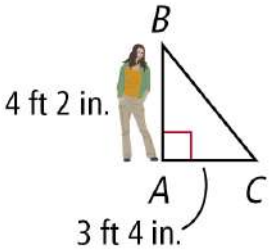
The perimeter of ΔABC is 14 mm, and the area is 10.7 mm^2.

Lesson Quiz: Part I

1. Maria is 4 ft 2 in. tall. To find the height of a flagpole, she measured her shadow and the pole's shadow. What is the height *h* of the flagpole?

25 ft



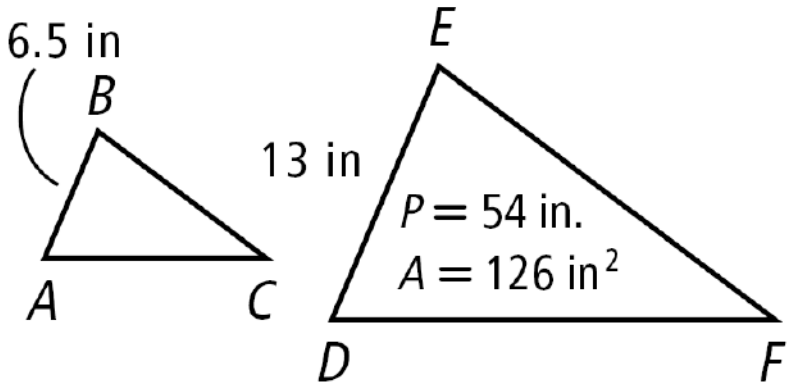


2. A blueprint for Latisha's bedroom uses a scale of 1 in.:4 ft. Her bedroom on the blueprint is 3 in. long. How long is the actual room?

12 ft

Lesson Quiz: Part II

3. $\Delta ABC \sim \Delta DEF$. Find the perimeter and area of ΔABC.



$P = 27$ in., $A = 31.5$ in^2