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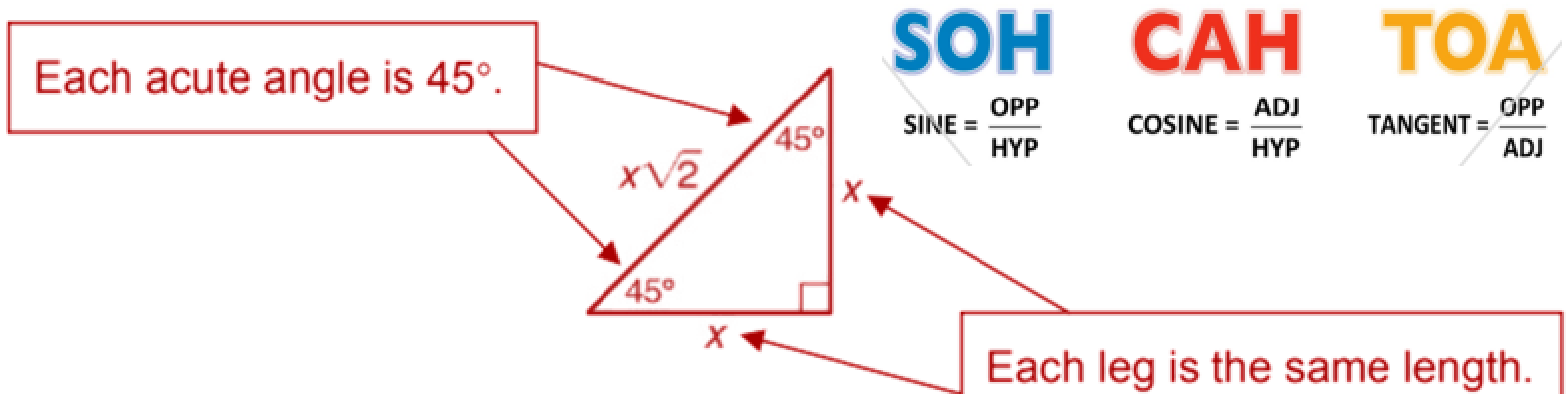
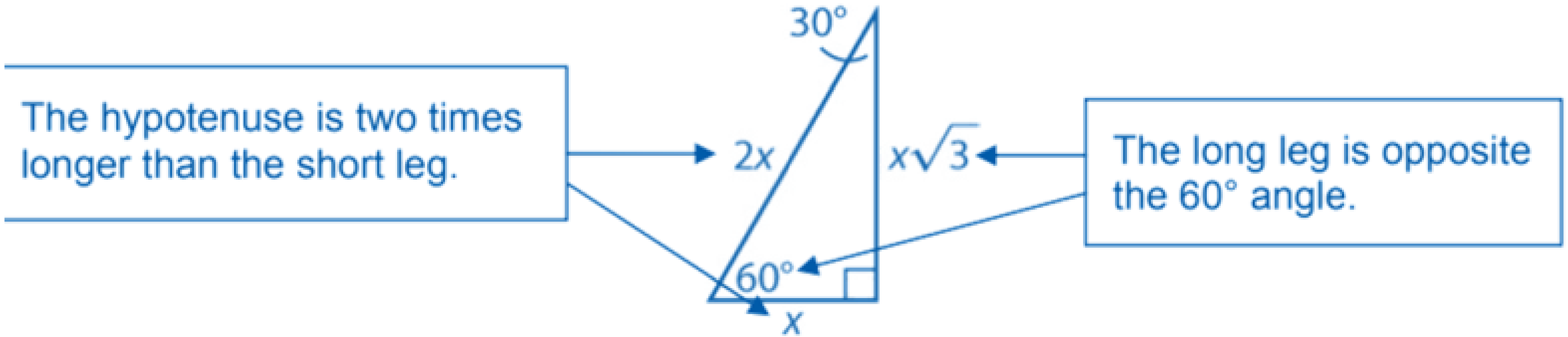
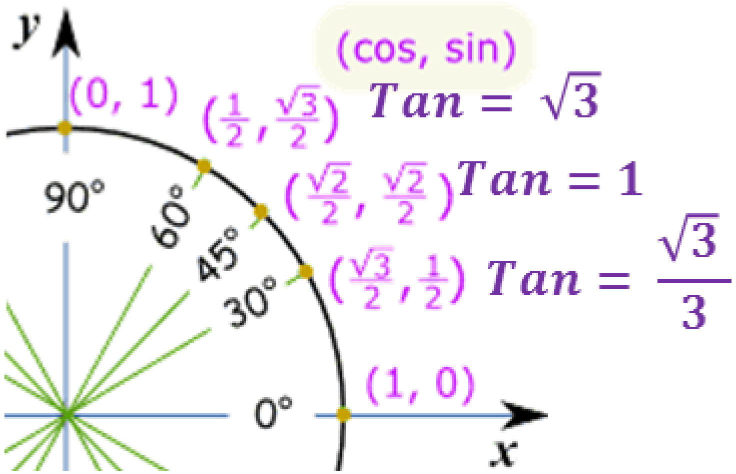
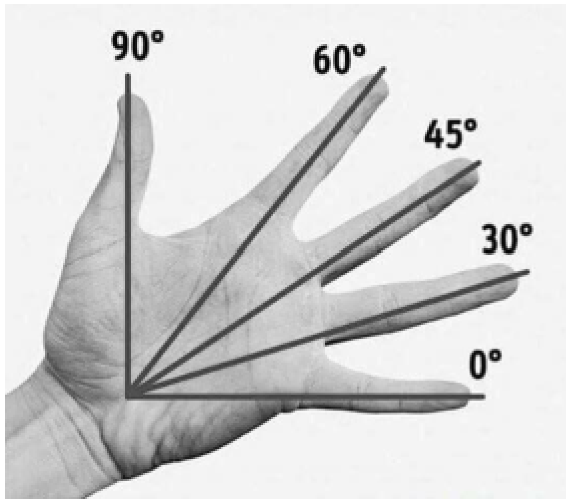
18.4 Problem Solving with Trigonometry

18.4

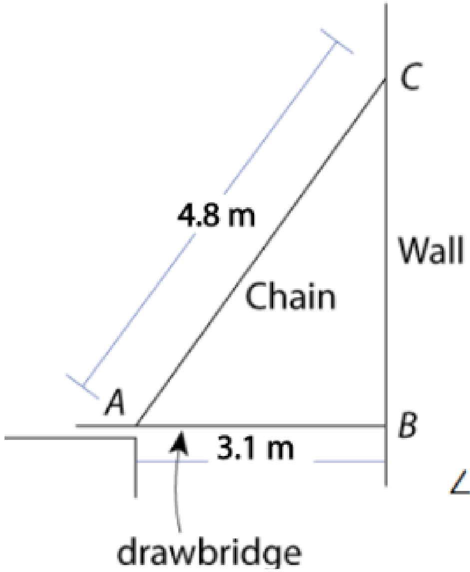

Each acute angle is 45°.
45°
45°
$x\sqrt{2}$
x
x
Each leg is the same length.
SOH
SINE = OPP / HYP
CAH
COSINE = ADJ / HYP
TOA
TANGENT = OPP / ADJ


30°
The hypotenuse is two times longer than the short leg.
$2x$
$x\sqrt{3}$
The long leg is opposite the 60° angle.
60°
x


(cos, sin)
y
(0, 1)
$(\frac{1}{2}, \frac{\sqrt{3}}{2})$ $Tan = \sqrt{3}$
$(\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2})$ $Tan = 1$
$(\frac{\sqrt{3}}{2}, \frac{1}{2})$ $Tan = \frac{\sqrt{3}}{3}$
90°
60°
45°
30°
0°
(1, 0)
x


90°
60°
45°
30°
0°

A drawbridge at the entrance to an ancient castle is raised and lowered by a pair of chains. The figure represents the drawbridge when flat. Find the height of the suspension point of the chain, to the nearest tenth of a meter, and the measures of the acute angles the chain makes with the wall and the drawbridge, to the nearest degree.



The measure of $\angle A$ is 50 °.

The measure of $\angle C$ is 40 °.

The height of the suspension point of the chain is 3.7 m.

$$m\angle A = \cos^{-1}\left(\frac{AB}{AC}\right) = \cos^{-1}\left(\frac{3.1}{4.8}\right) \approx 50^\circ$$

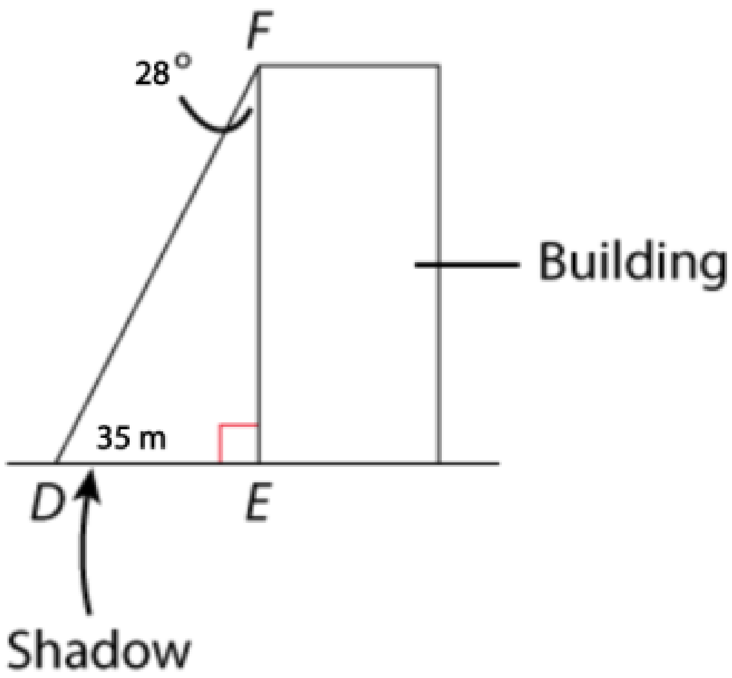
$\angle A$ and $\angle C$ are complementary, so $m\angle C \approx 90^\circ - 50^\circ = 40^\circ$.

Use the Pythagorean Theorem to find the length of the third side.

AC^2	$=$	$BC^2 + AB^2$	
$(4.8)^2$	$=$	$BC^2 + (3.1)^2$	Substitute 3.1 for AC and 4.8 for AB.
23.04	$=$	$BC^2 + 9.61$	Find the squares.
BC^2	$=$	13.43	Subtract 9.61 from both sides. Round your answer to the nearest hundredth.
BC	$=$	$\sqrt{13.43}$	Take the square root of both sides.
BC	$\approx$	3.7 m	Evaluate, rounding to the nearest tenth.

2 A building casts a 35 m shadow when the Sun is at an angle of 28° to the vertical. What angle does a ray from the Sun along the edge of the shadow make with the ground?

Use the fact that acute angles of a right triangle are complementary to find m D.



You know that the measure of the angle F is equal to 28° and the triangle is a right triangle.

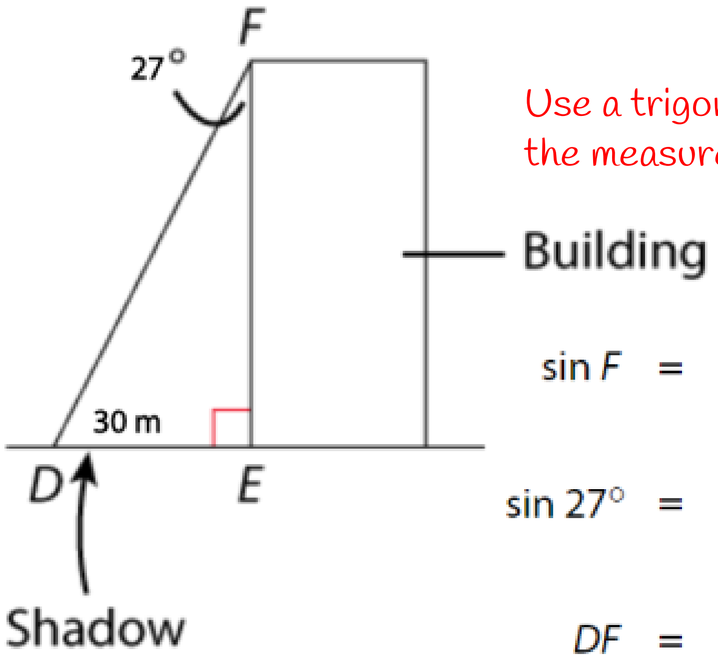
The sum of the two acute angles in a right triangle is 90°.

$$m\angle D + m\angle F = 90^\circ$$
$$m\angle D + 28^\circ = 90^\circ$$
$$m\angle D = 62^\circ$$

The measure of $\angle D$ is 62 °.

3 Use a trigonometric ratio to find the distance DF. Round your answer to the nearest integer.

A building casts a 30 m shadow when the Sun is at an angle of 27° to the vertical. How far is it from the top of the building to the tip of the shadow to the nearest meter? Use a trigonometric ratio to find the distance DF.



Use a trigonometric ratio to find DF. You know the length of DE and the measure of the angle that is opposite to DE, so use the sine ratio.

$\sin F = \dfrac{DE}{DF}$ Write a sine ratio for $\angle F$.

$\sin 27^\circ = \dfrac{30}{DF}$ Substitute 30 for DE. Substitute 27 for $\angle F$.

$DF = \dfrac{30}{\sin 27^\circ}$ Multiply both sides by DF. Divide both sides by $\sin 27^\circ$.

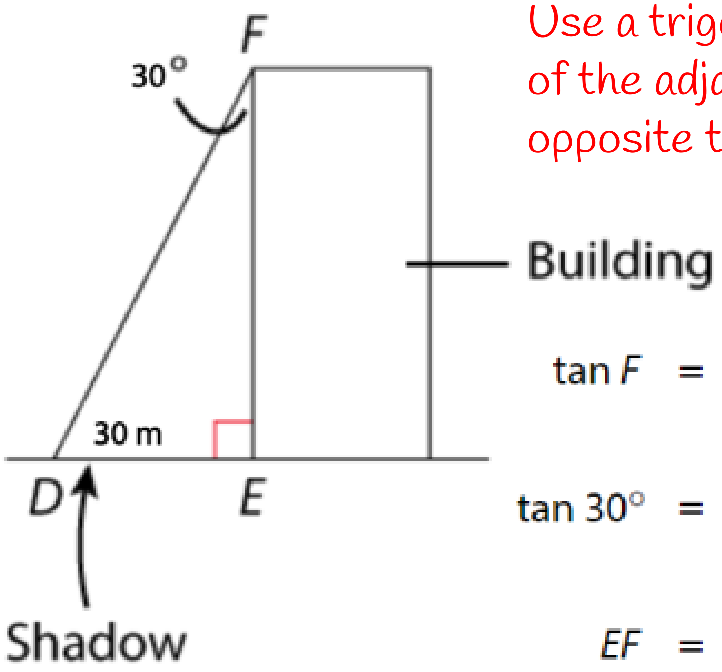
$DF \approx 66$ m Solve. Round your answer to the nearest meter.

The distance DF is 66 m.

4

Use a trigonometric ratio to find the distance EF.

A building casts a 30 m shadow when the Sun is at an angle of 30° to the vertical. How tall is the the building, to the nearest meter? Use a trigonometric ratio to find the distance FE.



Use a trigonometric ratio to find EF. You know the measure of the adjacent angle is 30° and the length of the side that is opposite to the angle 30° is 30 m, so use the tangent ratio.

$\tan F = \frac{DE}{EF}$ Write a tangent ratio for $\angle F$.

$\tan 30^\circ = \frac{30}{EF}$ Substitute 30 for DE. Substitute 30 for $\angle F$.

$EF = \frac{30}{\tan 30^\circ}$ Multiply both sides by EF. Divide both sides by $\tan 30^\circ$.

$EF \approx 52$ m Evaluate, rounding to the nearest meter.

The length $\overline{EF}$ is approximately 52 m.

5

A painter is placing a ladder to reach the third story window, which is 38 feet above the ground and makes an angle with the ground of 70°.

How far out from the building does the base of the ladder need to be positioned? Round your answer to the nearest tenth.

The base of the ladder needs to be positioned 13.8 **feet out from the building.**

Enter a tangent ratio that involves the unknown length.

$$\tan 70^\circ = \frac{38}{x}$$

$$x = \frac{38}{\tan 70^\circ}$$ Solve for x.

$$x \approx \frac{38}{2.74746859767}$$ Use a calculator to find $\tan 70^\circ$.

$$x \approx 13.8$$ Multiply. Round to the nearest tenth.

The base of the ladder needs to be positioned 13.8 feet out from the building

6 A ladder needs to reach a second-story window that is 12 feet above the ground and make an angle with the ground of 73°. How far out from the building does the base of the ladder need to be positioned? Round your answer to the nearest tenth.

The base of the ladder needs to be 3.7 feet away from the wall.

Let x be the distance from the bottom of the wall to the base of the ladder.

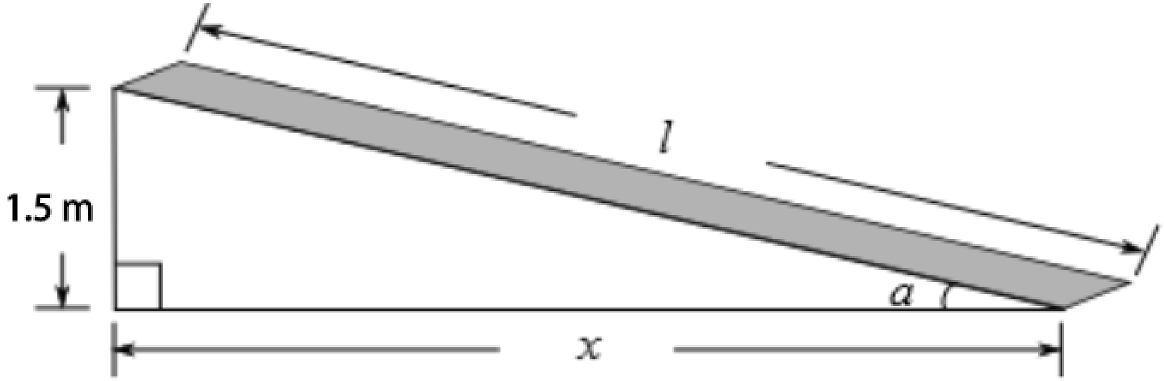
$$\tan 73^\circ = \frac{12}{x}$$

$$x = \frac{12}{\tan 73^\circ}$$

$$\approx 3.7$$ Evaluate. Round to the nearest tenth.

The base of the ladder needs to be 3.7 feet away from the wall.

7 A client wants to build a ramp that carries people to a height of 1.5 meters, as shown in the diagram.



Select the choice that describes what additional information is necessary to identify the measure of angle a, the angle the ramp forms with the horizontal, and how to use that measurement to find the measure of the angle.

Select the correct definition of tangent.

$$\text{tangent} = \frac{\text{opposite}}{\text{adjacent}}$$

The side of length 1.5 m is opposite the angle a and the side adjacent to $\angle a$ is x.

Measure the horizontal length of the ramp, x. Then use $m\angle a = \tan^{-1}\left(\frac{1.5}{x}\right)$.

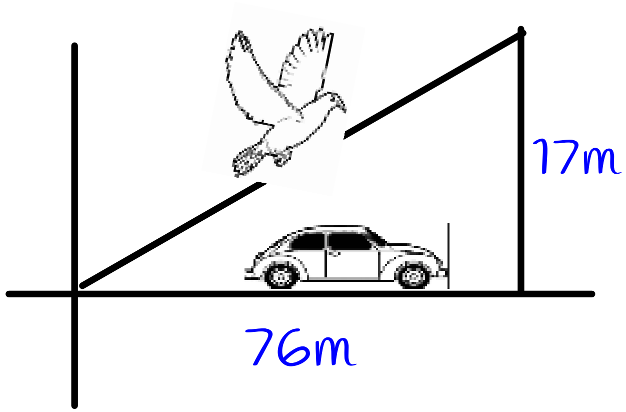
A **Measure the horizontal length of the ramp, x. Then use $m\angle a = \tan^{-1}\left(\frac{1.5}{x}\right)$.**

8 To travel from Pottstown to Cogsville, a man drives his car 76 miles due east on one road, and then 17 miles due north on another road. Describe the path that a bird could fly in a straight line from Pottstown to Cogsville. What angle does the line make with the two roads that the man used? Express your answers to the nearest tenth of a degree.

The bird's path forms an angle of 12.6 ° with the first (driving east) road and an angle of 77.4 ° with the second (driving north) road.

The bird's path is the hypotenuse of a right triangle formed by the two roads the man takes. The tangent of the angle the bird's path makes with the first road (driving east) is 17/76. The measure of the angle is

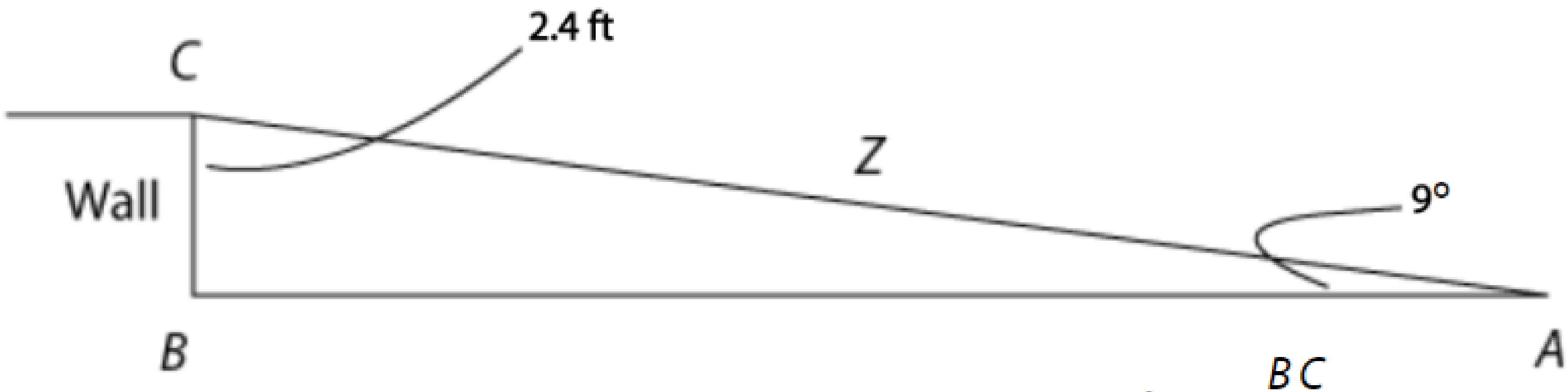
$$\tan^{-1}\left(\frac{17}{76}\right) = 12.6^\circ.$$



The measure of the angle between the bird's path and the second road (diving north) is

$$\tan^{-1}\left(\frac{76}{17}\right) = 77.4^\circ.$$

9 Suppose a new regulation states that the maximum angle of a ramp for wheelchairs is 9°. At least how long must the new ramp be? Round to the nearest tenth of a foot



The ramp must be at least 15.3 ft long.

The ramp must be at least long enough to create a 9° angle at A. Using the definition of sine and the height of the wall:

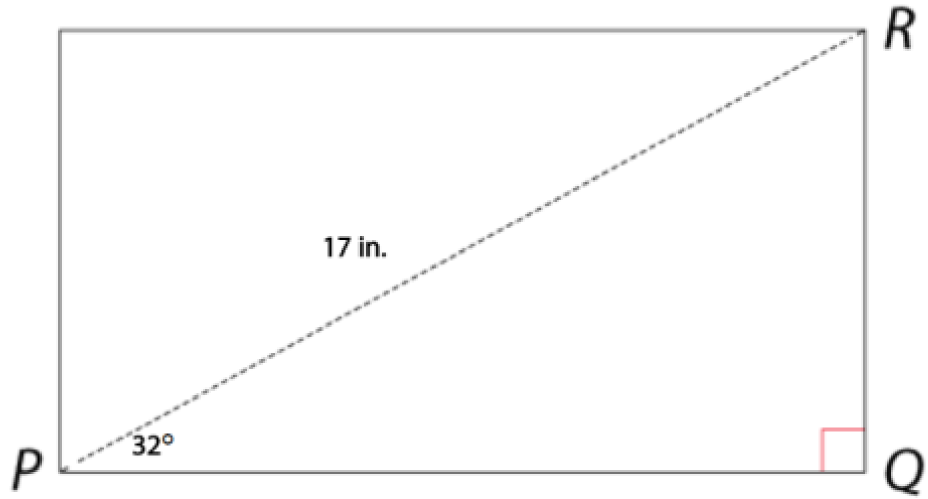
$$\sin A = \frac{BC}{AC}$$

$$\sin 9^\circ = \frac{2.4}{z}$$

$$z \approx \frac{2.4}{\sin 9^\circ}$$

$$z \approx 15.3$$

10 The specifications for a laptop computer describe its screen as measuring 17 in. However, this is actually the length of a diagonal of the rectangular screen, as represented in the figure. How wide is the screen horizontally, to the nearest tenth of an inch?



$PQ =$ 14.4 in.

$$\cos P = \frac{PQ}{PR}$$ Use the definition of cosine.

$$\cos 32^\circ = \frac{PQ}{17}$$ Substitute 32° for P and 17 for PR.

$$17\cos 32^\circ = PQ$$ Multiply both sides by 17.

$$PQ = 14.4 \text{ in.}$$ Use a calculator to evaluate the expressior


Never say,
"I can't"
Always say,
"I'll try"