

## What You'll Learn

- To find the sine and cosine ratios
- To solve problems using the sine and cosine ratios

## ...And Why

You can use the sine and cosine ratios to solve problems involving fire safety.

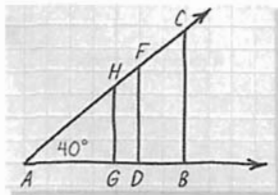
## Here's How

- Look for questions that
- build understanding
- check understanding

## Work Together

Exploring Sine and Cosine Ratios

1. a. Using graph paper and a protractor, draw  $\angle A$ , a  $40^\circ$  angle with one side on a horizontal line. Then choose vertical lines to draw segments  $\overline{HG}$ ,  $\overline{FD}$ , and  $\overline{CB}$  as shown.



- b. Use a centimeter ruler to measure the segments in the first three columns below to the nearest millimeter. Use a calculator to find the ratios in the fourth and fifth columns.

$BC = \blacksquare$	$AB = \blacksquare$	$AC = \blacksquare$	$\frac{BC}{AC} = \blacksquare$	$\frac{AB}{AC} = \blacksquare$
$DF = \blacksquare$	$AD = \blacksquare$	$AF = \blacksquare$	$\frac{DF}{AF} = \blacksquare$	$\frac{AD}{AF} = \blacksquare$
$GH = \blacksquare$	$AG = \blacksquare$	$AH = \blacksquare$	$\frac{GH}{AH} = \blacksquare$	$\frac{AG}{AH} = \blacksquare$

- c. **Patterns** Compare your ratios with those of other members of your group. What patterns do you find?

2. Repeat Question 1, but this time, use  $m\angle A = 73^\circ$ .

## THINK AND DISCUSS

## 1 Finding the Sine and Cosine Ratios

The tangent ratio involves the lengths of the legs of a right triangle. The sine and cosine ratios involve the lengths of the hypotenuse and one of the legs. These three ratios are called **trigonometric ratios**.

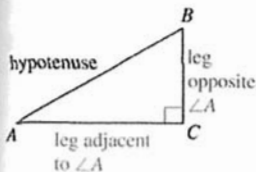
$$\text{sine of } \angle A = \frac{\text{length of leg opposite } \angle A}{\text{length of hypotenuse}}$$

$$\text{cosine of } \angle A = \frac{\text{length of leg adjacent to } \angle A}{\text{length of hypotenuse}}$$

These equations can be abbreviated.

$$\sin A = \frac{\text{opposite}}{\text{hypotenuse}}$$

$$\cos A = \frac{\text{adjacent}}{\text{hypotenuse}}$$

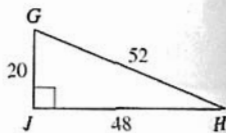


## EXAMPLE 1

Find  $\sin G$  and  $\cos G$ .

$$\sin G = \frac{\text{opposite}}{\text{hypotenuse}} = \frac{48}{52} = \frac{12}{13}$$

$$\cos G = \frac{\text{adjacent}}{\text{hypotenuse}} = \frac{20}{52} = \frac{5}{13}$$



3. **Try It Out** Find  $\sin H$  and  $\cos H$ .

- Calculator** You can use a calculator to find the sine and cosine of any acute angle of a right triangle.

To find  $\sin 41^\circ$  and  $\cos 41^\circ$ , use these key sequences.

$$41 \text{ [SIN] } 0.656059 \quad \text{So, } \sin 41^\circ \approx 0.6561.$$

$$41 \text{ [COS] } 0.7547096 \quad \text{So, } \cos 41^\circ \approx 0.7547.$$

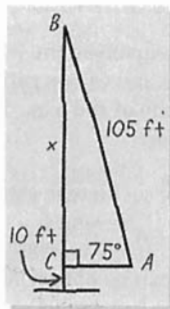
4. **Calculator** Find  $\sin 83^\circ$  and  $\cos 39^\circ$  to the nearest ten-thousandth.

## 2 Using the Sine and Cosine Ratios

You can use the sine and cosine ratios to solve problems.

## EXAMPLE 2 Real-World Problem Solving

- Fire Safety** The longest ladder that a suburban fire department has is a 105-ft ladder mounted on top of a truck. For the safety of those on the ladder, the fire department does not want to extend the ladder to an angle greater than  $75^\circ$  with the roof of the truck. If the roof of the truck is 10 ft off the ground, find the highest point the ladder can reach.



Draw a diagram to describe the problem.

Let  $x$  = the side opposite the  $75^\circ$  angle.

$$\sin A = \frac{\text{opposite}}{\text{hypotenuse}} \quad \leftarrow \text{Use the sine ratio.}$$

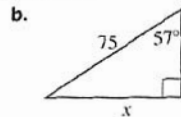
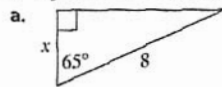
$$\sin 75^\circ = \frac{x}{105} \quad \leftarrow \text{Substitute.}$$

$$x = \sin 75^\circ(105) \quad \leftarrow \text{Solve for } x.$$

$$75 \text{ [SIN] } \times 105 = 101.42221$$

So,  $x \approx 101$ . Since the roof of the truck is 10 feet off the ground, the highest the ladder can reach is  $101 + 10$ , or 111 feet off the ground.

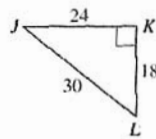
5. **Try It Out** Use the sine or cosine ratio to find  $x$ .



## EXERCISES On Your Own

Write each trigonometric ratio as a fraction in simplest form.

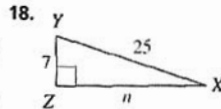
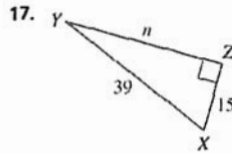
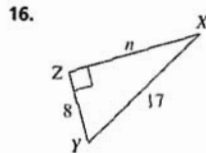
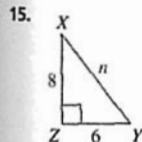
1.  $\sin J$       2.  $\cos J$       3.  $\sin L$   
 4.  $\cos L$       5.  $\tan J$       6.  $\tan L$



Use a calculator to find each sine or cosine. Round to the nearest ten-thousandth.

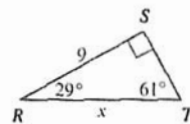
7.  $\sin 80^\circ$       8.  $\cos 4^\circ$       9.  $\sin 71^\circ$       10.  $\cos 19^\circ$   
 11.  $\sin 30^\circ$       12.  $\cos 60^\circ$       13.  $\cos 85^\circ$       14.  $\sin 45^\circ$

Use the Pythagorean theorem to find  $n$  in each figure below. Then write  $\sin X$ ,  $\cos X$ , and  $\tan X$  as fractions in simplest form.



19. **Writing** Your friend is having trouble figuring out whether to use the sine, cosine, or tangent ratio to solve a problem. Write an explanation of how to choose an appropriate ratio. Give one example using each trigonometric ratio.

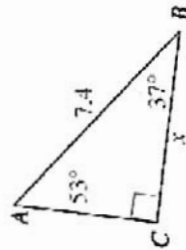
20. **Choose A, B, C, or D.** In  $\triangle RST$  at the right, which equation can you use to find  $x$ ?



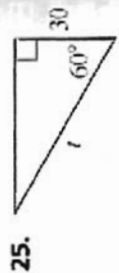
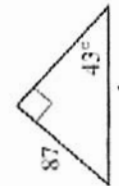
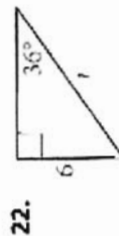
- I.  $\sin 61^\circ = \frac{9}{x}$       II.  $\cos 29^\circ = \frac{x}{9}$       III.  $\tan 29^\circ = \frac{9}{x}$   
 A. I only      B. I or II only      C. II or III only      D. I, II, or III

21. Refer to  $\triangle ABC$  at the right.

- a. Find  $x$  by writing and solving an equation that involves the sine ratio. Round to the nearest tenth.  
 b. Find  $x$  by writing and solving an equation that involves the cosine ratio. Round to the nearest tenth.



- In each figure, find  $t$ . Round to the nearest tenth.



26. **Water Parks** A slide at the Watermania Resort in Orlando, Florida, is called the Rainforest. It starts at a height of 20 ft and descends in a straight line that makes an angle of about  $30^\circ$  with the ground. About how long is the slide?

27. a. A 16-ft ladder rests against a building so that it forms a  $75^\circ$  angle with the ground. To the nearest tenth of a foot, what is the distance from the top of the ladder to the base of the building?  
 b. To the nearest tenth of a foot, what is the distance from the bottom of the ladder to the base of the building?

## PORTFOLIO

Select one or two items from your work for this chapter. Consider:

- corrected work
  - a journal entry
- Explain why you have included each selection that you make.