

# 1-4

# The Pythagorean Theorem

## ✓ Check Skills You'll Need

1. **Vocabulary Review**  
What is the *square root* of a number?

Estimate the value of each expression to the nearest integer.

2.  $\sqrt{60}$       3.  $\sqrt{111}$   
4.  $\sqrt{80}$       5.  $\sqrt{22}$

**GO** for Help  
Lesson 1-2

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8.G.7

## What You'll Learn

To use the Pythagorean Theorem to find the length of the hypotenuse of a right triangle

**New Vocabulary** legs, hypotenuse, Pythagorean Theorem

## Why Learn This?

The Pythagorean Theorem describes the special relationship among the sides of a right triangle. You can use the theorem to find the side lengths of right triangles in structures such as bridges.

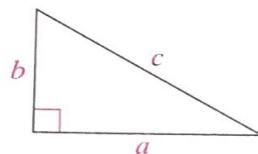


In a right triangle, the two shortest sides are **legs**. The longest side, which is opposite the right angle, is the **hypotenuse**. The **Pythagorean Theorem** is an equation that shows the relationship between the legs and the hypotenuse.

## KEY CONCEPTS The Pythagorean Theorem

In any right triangle, the sum of the squares of the lengths of the legs is equal to the square of the length of the hypotenuse.

$$a^2 + b^2 = c^2$$



You can use the Pythagorean Theorem to find the length of the hypotenuse of a right triangle if you know the lengths of the two legs.

## EXAMPLES Finding the Hypotenuse

- 1 Find the length of the hypotenuse of the triangle.

$$a^2 + b^2 = c^2$$

← Use the Pythagorean Theorem.

$$5^2 + 12^2 = c^2$$

← Substitute 5 for  $a$  and 12 for  $b$ .

$$25 + 144 = c^2$$

← Simplify.

$$169 = c^2$$

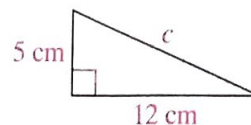
← Add.

$$\sqrt{169} = \sqrt{c^2}$$

← Find the positive square root of each side.

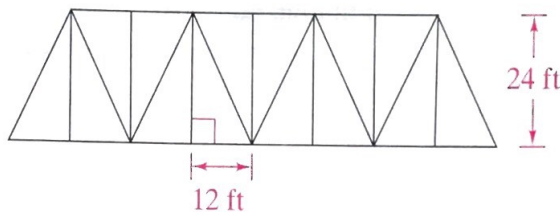
$$13 = c$$

← Simplify.



The length of the hypotenuse is 13 cm.

- 2 **Multiple Choice** An architect drew the sketch of a bridge shown below. The bridge has 12-ft-long horizontal members and 24-ft-long vertical members. What is the length in feet of each diagonal member? Round to the nearest foot.



(A) 720 ft

(C) 21 ft

(B) 27 ft

(D) 12 ft

Each diagonal member is the hypotenuse of a right triangle.

$$a^2 + b^2 = c^2$$

← Use the Pythagorean Theorem.

$$12^2 + 24^2 = c^2$$

← Substitute 12 for  $a$  and 24 for  $b$ .

$$144 + 576 = c^2$$

← Simplify.

$$720 = c^2$$

← Add.

$$\sqrt{720} = \sqrt{c^2}$$

← Find the positive square root of each side.



$$26.83281573 = c$$

← Use a calculator.

$$27 \approx c$$

← Simplify.

The length of each diagonal member is about 27 ft. The answer is B.

### Quick Check

- Find the length of the hypotenuse of a right triangle with legs of 12 cm and 16 cm.
- A bridge has 22-ft horizontal members and 25-ft vertical members. Find the length of each diagonal member to the nearest foot.

GO Online

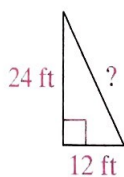


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### Test Prep Tip

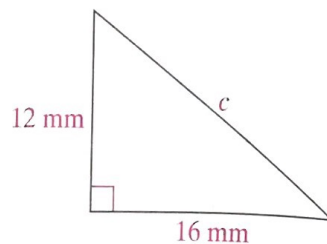
Draw and label a picture of a right triangle like the one below to match the problem situation.



# Check Your Understanding

- Vocabulary** The side lengths of a right triangle are 5, 12, and 13. How do you know that the length of the hypotenuse is 13? Explain.
- Fill in the blanks for each step to find the missing hypotenuse length of the triangle below.

- $12^2 + \blacksquare^2 = c^2$
- $\blacksquare + 256 = c^2$
- $\blacksquare = c^2$
- $\blacksquare = c$



## Homework Exercises

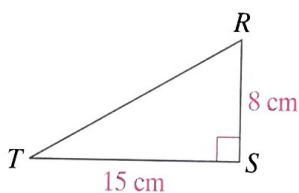
For more exercises, see **Extra Skills and Word Problems**.

### GO for Help

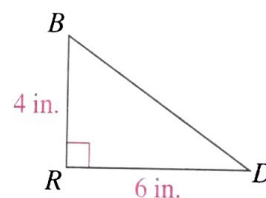
For Exercises	See Examples
3–13	1, 2

Find the length of the hypotenuse of each triangle. For Exercises 7–12,  $a$  and  $b$  represent the lengths of the two legs. If necessary, round to the nearest tenth.

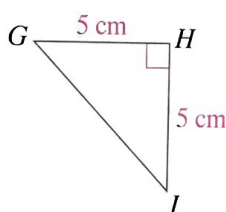
3.



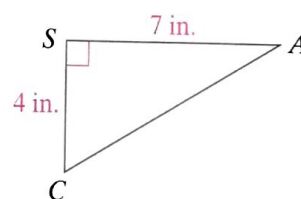
4.



5.



6.



7.  $a = 3, b = 4$

8.  $a = 9, b = 12$

9.  $a = 7, b = 24$

10.  $a = 6, b = 5$

11.  $a = 11, b = 14$

12.  $a = 18, b = 22$

- Ramps** A ramp is 1 ft high. The base of the ramp extends 14 ft along the side of a building. How long is the sloped part of the ramp to the nearest hundredth of a foot?

### GPS

- Guided Problem Solving** Find the perimeter of a right triangle with legs of 6 cm and 8 cm.
  - Make a Plan** First use the Pythagorean Theorem to find the length of the hypotenuse. Then find the perimeter of the triangle.
  - Carry Out the Plan** The hypotenuse is  $\blacksquare$  cm long. The perimeter of the triangle is  $\blacksquare$  cm.

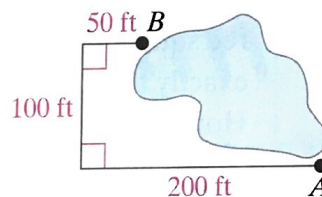
15. **Television** A television is measured by the diagonal dimension of its screen. For example, a 24-in. television has a diagonal measure of 24 in.
- A television screen is 16 in. high and 22 in. wide. What is its diagonal dimension to the nearest integer?
  - Find the dimensions of a television screen with the same diagonal measure as the one in part (a), but with a different height and width.

**The legs of a right triangle are equal. Given the length of the legs, find the length of the hypotenuse. Round to the nearest tenth.**

16. 5 cm                      17. 2 cm                      18. 10 in.                      19. 12 m

20. Two hikers start a trip from a camp walking 1.5 km due east. They turn due north and walk 1.7 km to a waterfall. To the nearest tenth of a kilometer, how far is the waterfall from the camp?

21. **Writing in Math** Explain how you would find the distance  $AB$  across the lake at the right. Then find  $AB$  to the nearest foot.



22. **Reasoning** If  $\sqrt{w}$  is an integer, how many values of  $w$  are between 20 and 120?

23. **Algebra** Is  $m = 3$  a solution to  $m^2 + (m + 1)^2 = (m + 2)^2$ ?

24. **Challenge** The sum of the squares of the lengths of all three sides of a right triangle is 200. What is the length of the hypotenuse?

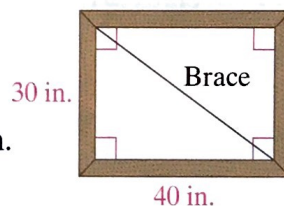


## Test Prep and Mixed Review

### Practice

#### Multiple Choice

25. A carpenter is attaching a brace to the back of the frame shown at the right. What is the length, in inches, of the brace?
- (A) 2,500 in.    (B) 50 in.    (C) 26.5 in.    (D) 10 in.



26. Nicole makes 15 free throws. She attempts a total of 24 free throws. What decimal represents the portion of free throws that Nicole does NOT make?
- (F) 0.375    (G)  $0.\overline{375}$     (H) 0.625    (J)  $0.\overline{625}$

27. A cube-shaped packing box has a side length of 7 inches. What is the volume of the packing box?
- (A) 14 cubic inches    (C) 49 cubic inches  
 (B) 21 cubic inches    (D) 343 cubic inches

#### GO for Help

For Exercises    See Lesson

28-31

1-3

**Solve each equation by finding the value of  $x$ .**

28.  $x^3 = 729$     29.  $x^3 = -512$     30.  $x^3 = \frac{1}{1,000}$     31.  $x^3 = \frac{343}{512}$