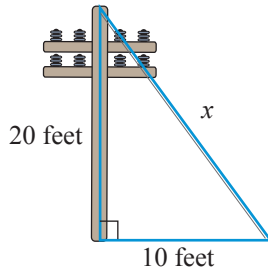


Example 8  **Application: Finding the Length of the Hypotenuse**

A guy wire is attached to the top of a telephone pole and anchored to the ground 10 feet from the base of the pole. If the pole is 20 feet high, what is the length of the guy wire to the nearest hundredth?


**Solution**

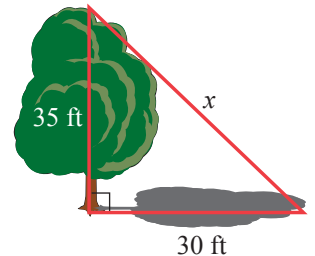
Let x = the length of the guy wire.

Then, by the Pythagorean Theorem:

$$\begin{aligned}x^2 &= 10^2 + 20^2 \\x^2 &= 100 + 400 \\x^2 &= 500 \\x &= \sqrt{500} \approx 22.36\end{aligned}$$

The guy wire is about 22.36 feet long.

8.  A 35-foot-tall tree casts a shadow which is 30 feet long. Find the distance from the top of the tree to the end of its shadow to the nearest hundredth.

**Now work margin exercise 8.****Margin Exercise Answers**

1. a. 324 b. 81 2. a. 6 b. 13 c. -7 d. -14 3. a. 64 b. 10 4. a. 2.2361 b. 3.8730 5. No, $8^2 \neq 7^2 + 4^2$ 6. 17 cm 7. 14.14 inches 8. 46.10 ft

6.10 Exercises

Concept Check

Fill-in-the-Blank. Complete each sentence using information found in this section.

- The complete expression $\sqrt{81}$ is a/an _____ or _____ expression.
- When a number is multiplied by itself, the result is a/an _____.
- The number under the radical sign is the _____.
- $\sqrt{\quad}$ is called a/an _____ sign.
- The Pythagorean Theorem can be helpful in finding the lengths of sides of _____ triangles.
- $c^2 = a^2 + b^2$ is the equation part of the _____ Theorem.

True/False. Determine whether each statement is true or false. If a statement is false, explain how it can be changed so the statement will be true. (**Note:** There may be more than one acceptable change.)

- 49 is a perfect square.
- In the expression $\sqrt{81}$, the number 9 is the radicand.
- The Pythagorean Theorem can be used to find the length of the longest side of a right triangle if the lengths of the two legs are known.
- The Pythagorean Theorem works for any type of triangle.


Practice

State whether or not each number is a perfect square.

- | | | | |
|-------|-------|--------|--------|
| 1. 16 | 3. 45 | 5. 400 | 7. 121 |
| 2. 48 | 4. 40 | 6. 256 | 8. 144 |

Evaluate each expression. See Examples 1 through 3.

- | | | | |
|------------|------------------|-------------------|----------------------|
| 9. 12^2 | 13. $\sqrt{36}$ | 17. $\sqrt{225}$ | 21. $(\sqrt{16})^2$ |
| 10. 17^2 | 14. $\sqrt{81}$ | 18. $\sqrt{361}$ | 22. $(\sqrt{49})^2$ |
| 11. 20^2 | 15. $\sqrt{169}$ | 19. $\sqrt{1600}$ | 23. $(\sqrt{206})^2$ |
| 12. 8^2 | 16. $\sqrt{196}$ | 20. $\sqrt{4900}$ | 24. $(\sqrt{352})^2$ |



 Use a calculator to approximate each square root to the nearest ten-thousandth. See Example 4.





- | | | | |
|-----------------|-------------------|---------------------|-----------------------|
| 25. $\sqrt{12}$ | 30. $\sqrt{15}$ | 35. $\sqrt{3.61}$ | 40. $\sqrt{1030.41}$ |
| 26. $\sqrt{28}$ | 31. $\sqrt{288}$ | 36. $\sqrt{2.25}$ | 41. $\sqrt{0.0009}$ |
| 27. $\sqrt{48}$ | 32. $\sqrt{363}$ | 37. $\sqrt{1.5129}$ | 42. $\sqrt{0.000025}$ |
| 28. $\sqrt{45}$ | 33. $\sqrt{0.81}$ | 38. $\sqrt{4.6225}$ | 43. $\sqrt{0.003}$ |
| 29. $\sqrt{19}$ | 34. $\sqrt{0.16}$ | 39. $\sqrt{9.0601}$ | 44. $\sqrt{0.004}$ |

Answer each question.

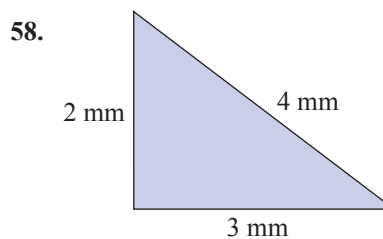
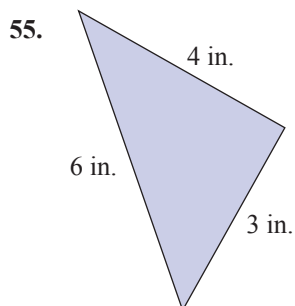
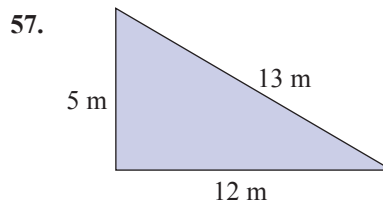
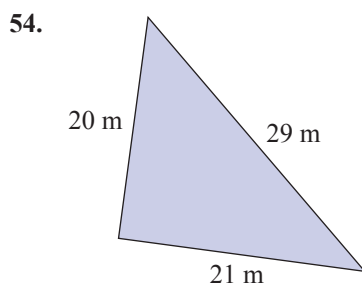
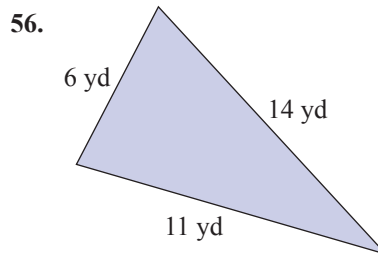
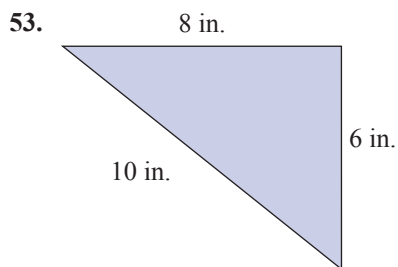
45. **a.** Do you think that $\sqrt{39}$ is more than 6 or less than 6? Explain your reasoning.
b. Do you think that $\sqrt{39}$ is more than 7 or less than 7? Explain your reasoning.
46. **a.** Do you think that $\sqrt{18}$ is more than 4 or less than 4? Explain your reasoning.
b. Do you think that $\sqrt{18}$ is more than 5 or less than 5? Explain your reasoning.


For each problem, **a.** use your understanding of square roots to estimate the value of each square root. Then, **b.** use your calculator to find the value of each square root accurate to the nearest ten-thousandth.

47. **a.** The nearest integers to $\sqrt{95}$ are ____ and ____.
b.  Find the value of $\sqrt{95}$.
48. **a.** The nearest integers to $\sqrt{28}$ are ____ and ____.
b.  Find the value of $\sqrt{28}$.

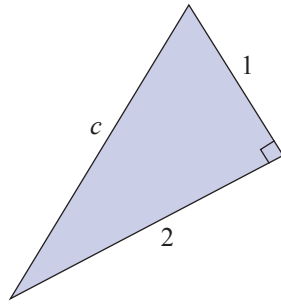
49. a. The nearest whole numbers to $\sqrt{13}$ are ____ and ____.
 b.  Find the value of $\sqrt{13}$.
50. a. The nearest integers to $\sqrt{72}$ are ____ and ____.
 b.  Find the value of $\sqrt{72}$.
51. a. The nearest integers to $\sqrt{50}$ are ____ and ____.
 b.  Find the value of $\sqrt{50}$.
52. a. The nearest integers to $\sqrt{105}$ are ____ and ____.
 b.  Find the value of $\sqrt{105}$.

Use the Pythagorean Theorem to determine whether or not each triangle is a right triangle. See Example 5.

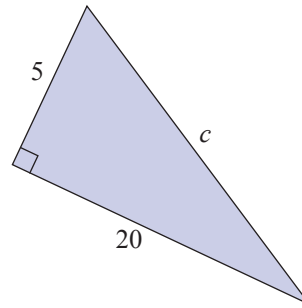


 Find the hypotenuse for each right triangle accurate to the nearest hundredth. See Example 6.

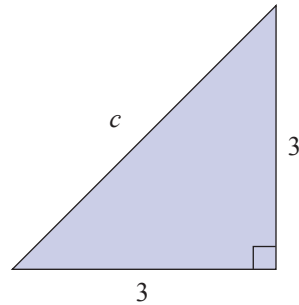
59.



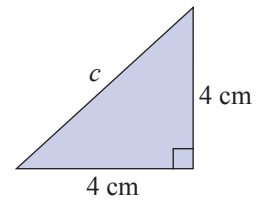
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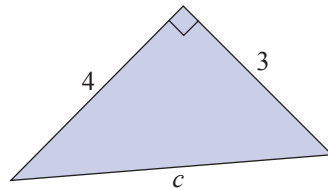
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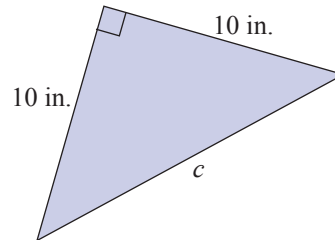
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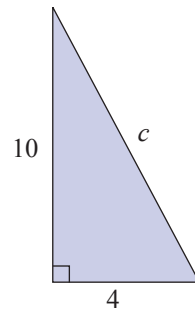
61.



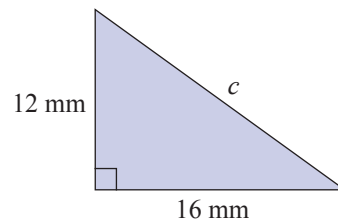
65.




62.

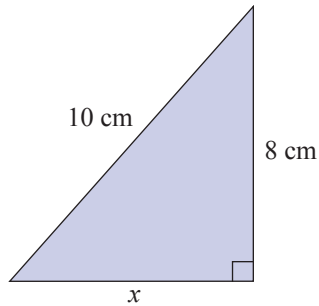


66.

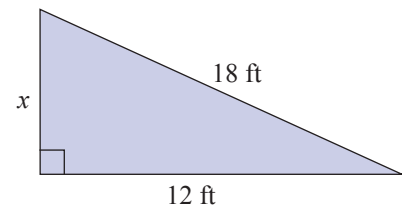


 Find the length of the missing leg for each triangle accurate to the nearest hundredth. See Example 7.

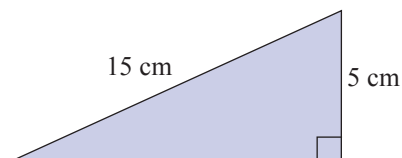
67.



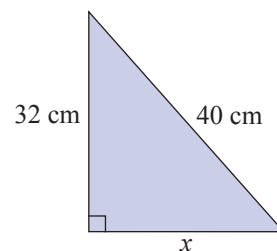
69.



68.

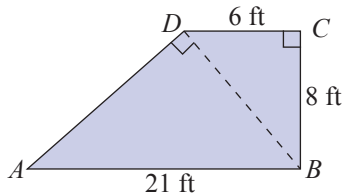


70.

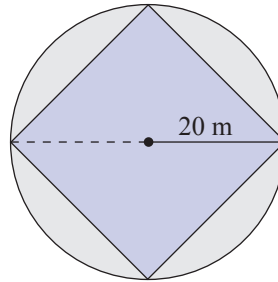


Solve.

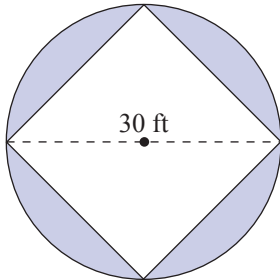
71. Find the lengths (accurate to the nearest hundredth) of the line segments \overline{BD} and \overline{AD} in the figure shown.



72. Find the length of one side of the square in the figure shown with the square inscribed in a circle of radius 20 meters. (Each corner of the square lies on the circle.) Use $\pi \approx 3.14$.



73. A square is inscribed in a circle with diameter 30 feet as shown in the figure. Use $\pi \approx 3.14$



- Find the circumference of the circle.
- Find the area of the circle.
- Find the perimeter of the square.
- Find the area of the square.
- Find the area of the shaded region in the figure.

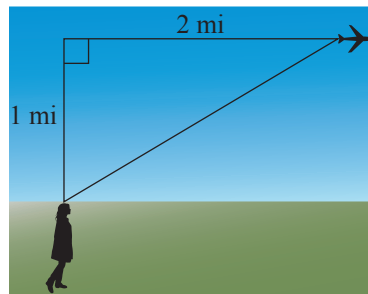
74. A square has a diagonal of length 18 yd.

- What is the perimeter of the square?
- What is the area of the square?

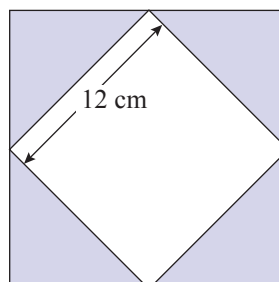
Applications

Solve.

75. If an airplane passes directly over your head at an altitude of 1 mile, how far (to the nearest hundredth of a mile) is the airplane from your position after it has flown 2 miles farther at the same altitude?

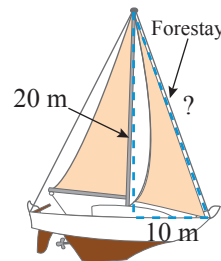


76. To create a square inside a square, a quilting pattern requires four triangular pieces like the one shaded in the figure shown here. If the square in the center measures 12 centimeters on a side and two legs of each triangle are of equal length, how long are the legs of each triangle to the nearest tenth of a centimeter?

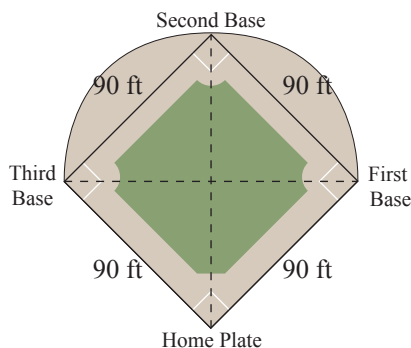


77. The GE Building in New York is 850 feet tall (70 stories). At a certain time of day, the building casts a shadow 100 feet long. Find the distance from the top of the building to the tip of the shadow (to the nearest tenth of a foot).
78. The base of a fire engine ladder is 30 feet from a building and reaches to a third floor window 50 feet above ground level. Find the length of the ladder to the nearest hundredth of a foot.

79. A forestay that helps support a ship's mast reaches from the top of the mast, which is 20 meters high, to a point on the deck 10 meters from the base of the mast. What is the length of the forestay (to the nearest tenth of a meter)?

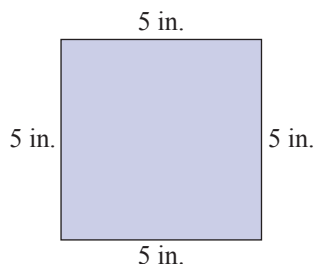


80. The Xerox Center building in Chicago is 500 feet tall. At a certain time of day, it casts a shadow that is 150 feet long. At that time of day, what is the distance (to the nearest tenth of a foot) from the tip of the shadow to the top of the Xerox building?
81. The shape of a baseball infield is a square with sides 90 feet long.



- a. Find the distance (to the nearest tenth of a foot) from home plate to second base.
- b. The diagonals of the square intersect halfway between home plate and second base. If the pitcher's mound is 60.5 feet from home plate, is the pitcher's mound closer to home plate or to second base?

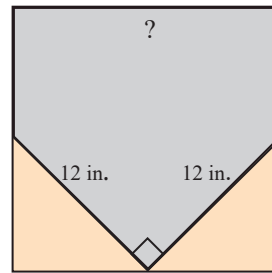
82. A diagonal of a square is the line segment from one corner to an opposite corner of a square. A square has side length of 5 in.



- a. Find the perimeter of the square.
- b. Find the area of the square.
- c. Find the length of a diagonal of the square.

83. Before painting a picture on canvas, an artist must stretch the canvas on a rectangular wooden frame. To be sure that the corners of the canvas are true right angles, the artist can measure the diagonals of the stretched canvas. What should be the diagonal measure, to the nearest tenth of an inch, of a canvas whose sides are 24 inches and 30 inches in length?
84. While installing windows in a new home, a builder measures the diagonals of rectangular window casements to verify that their corners are true right angles. What should be the diagonal measure, to the nearest tenth of an inch, of a window casement with dimensions 36 inches and 54 inches.

85. The shape of home plate in the game of baseball can be created by cutting off two triangular pieces at the corners of a square, as shown in the figure. If each of the triangular pieces has a hypotenuse of 12 inches and legs of equal length, what is the length of one side of the original square, to the nearest tenth of an inch?



86. The city needs to replant an 18-foot tree. To ensure the tree does not fall over, three wires are to be attached to the tree 3 feet from the top. The wires will extend 8 feet from the base of the tree.
- How long will each wire be? Round to the nearest hundredth.
 - What will be the total length of the three wires?
87. A hiker hikes 9 kilometers north and then turns left and hikes 11 kilometers west. If she takes the shortest path, how long will she have to walk to get back? Assume the terrain is flat with no obstructions. Round the answer to the closest tenth.

Writing & Thinking

88. Explain the connection between a perfect square and its square root. Give an example.
89. Determine the difference between a radical sign, radicand, and radical expression.
90. State the Pythagorean Theorem and give an application of how you might use it.
91. If three whole numbers satisfy the Pythagorean Theorem, these three numbers are called a Pythagorean triple. For example, 3, 4, and 5 are a Pythagorean triple because $3^2 + 4^2 = 5^2$ (or $9 + 16 = 25$). Another Pythagorean triple is 5, 12, and 13 because $5^2 + 12^2 = 13^2$ (or $25 + 144 = 169$). Complete the following table by finding a , b , and c , and telling which sets of these three numbers (if any) constitute a Pythagorean triple. The first one is done for you.

m	n	$a = 2nm$	$b = m^2 - n^2$	$c = m^2 + n^2$	Pythagorean Triple?
5	1	10	24	26	yes: $10^2 + 24^2 = 26^2$
7	1				
3	2				
7	2				
5	3				
11	3				
13	7				

Extension: Choose some of your own numbers for m and n . Are your results Pythagorean triples? (**Note:** m must be larger than n so $m^2 - n^2$ will be positive.)