The square root of a number, \( n \), written below is the number that gives \( n \) when multiplied by itself.

\[
\sqrt{n}
\]

\[
\sqrt{100} = 10 \\
\text{because } 10 \times 10 = 100
\]

Square Roots and the Pythagorean Theorem
Lesson
“Tutors with Vision” Project
Center for Teacher Certification
Austin Community College

Spring 2008

Nancy Shaer has over 30 years of experience working with students in Austin Independent School District. She is a Master Teacher who has the intuition, expertise, experience, and “6th Sense” that she uses with her students and shares with others. We appreciate her enthusiasm in claiming the first to embrace the “Tutors with Vision” project. Abel L. Villarreal, Center for Teacher Certification Math Specialist and ACC Mathematics Professor, also has over 30 years in the classroom and has worked with Ms. Shaer to create a packet that contains essentials for teaching – and for learning – how to use student data to teach. We move forward to square roots and the Pythagorean Theorem, scaffolding from measurement, equations, proportions, scientific notation and exponents, and percentage.

Packet 10
Square Roots and Pythagorean Theorem, TEKS Objective 5 (p. 2)
Square Roots and Pythagorean Theorem Practice, Objective 5 (p.3)
Answer Keys, Objective 5 (pp. 4-5)
TAKS Practice Objective 7 (Booklet) - problems #34, 76
Reflection (p. 6)
Square Roots & Pythagorean Theorem
Algebra 1

An easy way to remember “squares” is to think of the times tables that multiply the same number twice.

\begin{align*}
  2^2 &= 2 \cdot 2 = 4 \\
  3^2 &= 3 \cdot 3 = 9 \\
  4^2 &= 4 \cdot 4 = 16
\end{align*}

\begin{align*}
  5^2 &= 5 \cdot 5 = 25 \\
  6^2 &= 6 \cdot 6 = 36 \\
  7^2 &= 7 \cdot 7 = 49 \\
  8^2 &= 8 \cdot 8 = 64 \\
  9^2 &= 9 \cdot 9 = 81 \\
  10^2 &= 10 \cdot 10 = 100
\end{align*}

\begin{align*}
  11^2 &= 11 \cdot 11 = 121 \\
  12^2 &= 12 \cdot 12 = 144 \\
  13^2 &= 13 \cdot 13 = 169
\end{align*}

Sometimes you will be asked to go backwards and write the number that is multiplied twice. We called the square’s opposite a square root. A square root has the symbol \(\sqrt{}\).

\begin{align*}
  \sqrt{1} &= 1 \\
  \sqrt{4} &= 2 \\
  \sqrt{9} &= 3 \\
  \sqrt{16} &= 4 \\
  \sqrt{25} &= 5 \\
  \sqrt{36} &= 6 \\
  \sqrt{49} &= 7 \\
  \sqrt{64} &= 8 \\
  \sqrt{81} &= 9 \\
  \sqrt{100} &= 10 \\
  \sqrt{111} &= 11 \\
  \sqrt{121} &= 12 \\
  \sqrt{144} &= 13
\end{align*}

Some square roots are not exact and have to be approximated. For example, \(\sqrt{12}\) is somewhere between \(\sqrt{9} = 3\) and \(\sqrt{16} = 4\). The \(\sqrt{12}\) appears to be very close to the middle, so we approximate to 3.5. To check it, we do 3.5 \(\cdot\) 3.5 and get 12.25. This means that 3.5 is a good approximation for \(\sqrt{12}\). Try these square roots.

**Examples:**

Approximate \(\sqrt{31}\)

Approximate \(\sqrt{53}\)

Imagine a special triangle with a 90º angle and the length of two short sides (called legs) given. To find the length of the longest side (called hypotenuse), use the Pythagorean Theorem, \(a^2 + b^2 = c^2\). Such a triangle is called a right triangle.

For over 2400 years, the Pythagorean Theorem has been used to build great cities and support technological advancements. Some scholars believe that this theorem is 1000 years older than Pythagoras.

**Example:** Find the length of the missing side of the triangle.

\begin{align*}
  a &= ? \\
  b &= 6 \\
  c &= 8
\end{align*}

\begin{align*}
  a^2 + b^2 &= c^2 \\
  ?^2 + 6^2 &= 8^2 \\
  ?^2 + 36 &= 64 \\
  ?^2 &= 28 \\
  ? &= \sqrt{28}
\end{align*}

**Example:** Draw a right triangle having one leg that measures 12 inches and has a hypotenuse of 20 inches. Now find the length of the missing leg.
Name________________  Square Roots & Pythagorean Theorem
Algebra 1

<table>
<thead>
<tr>
<th>Answer the following.</th>
<th>10. Approximate $\sqrt{115}$ to tenths.</th>
<th>14. Which number is closer to $\sqrt{73}$? 8.6 or 8.3?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. $9 \cdot 9 = ___$</td>
<td>----------------------------------------</td>
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<tr>
<td>2. $12^2 = ___$</td>
<td>----------------------------------------</td>
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<tr>
<td>3. $\sqrt{49} = ___$</td>
<td>----------------------------------------</td>
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<tr>
<td>4. $\sqrt{56}$ is between the integers __ and __.</td>
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<td>5. $\sqrt{100} = ___$</td>
<td>----------------------------------------</td>
<td>------------------------------------------------------</td>
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<tr>
<td>6. $\sqrt{64} = ___$</td>
<td>----------------------------------------</td>
<td>------------------------------------------------------</td>
</tr>
<tr>
<td>7. True or False. $\sqrt{36 + 64} = \sqrt{36} + \sqrt{64}$</td>
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<td>------------------------------------------------------</td>
</tr>
<tr>
<td>8. Draw a right triangle that has legs of 6 and 8, and has a hypotenuse of 10.</td>
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<td>------------------------------------------------------</td>
</tr>
<tr>
<td>9. Find the missing side in the right triangle below.</td>
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<td>------------------------------------------------------</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>11. Approximate $\sqrt{80}$ to tenths</th>
<th>12. Approximate the length of the square’s diagonal to tenths.</th>
<th>15. A park is shaped like a square. The park area is 420 m$^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(a) What are the park’s dimensions?</td>
<td>(b) What is the park’s perimeter?</td>
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</table>

| 13. Approximate the width of the rectangle’s to tenths. | 16. Choose $>, <$, or $\_\_\_\_$, $\sqrt{25} \cdot \sqrt{121}$ $\_\_\_\_\_$, $\sqrt{25} \cdot \sqrt{21}$ |
|------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|
|                                                     |                                                               |                                                               |
Square Roots & Pythagorean Theorem (KEY)
Algebra 1

An easy way to remember “squares” is to think of the times tables that multiply the same number twice.

\[ 2^2 = 2 \cdot 2 = 4 \quad 5^2 = 5 \cdot 5 = 25 \quad 8^2 = 8 \cdot 8 = 64 \quad 11^2 = 11 \cdot 11 = 121 \]
\[ 3^2 = 3 \cdot 3 = 9 \quad 6^2 = 6 \cdot 6 = 36 \quad 9^2 = 9 \cdot 9 = 81 \quad 12^2 = 12 \cdot 12 = 144 \]
\[ 4^2 = 4 \cdot 4 = 16 \quad 7^2 = 7 \cdot 7 = 49 \quad 10^2 = 10 \cdot 10 = 100 \quad 13^2 = 13 \cdot 13 = 169 \]

Sometimes you will be asked to go backwards and write the number that is multiplied twice. We called the square’s opposite a square root. A square root has the symbol \( \sqrt{\quad} \).

\[ \sqrt{1} = 1 \quad \sqrt{16} = 4 \quad \sqrt{49} = 7 \quad \sqrt{100} = 10 \]
\[ \sqrt{4} = 2 \quad \sqrt{25} = 5 \quad \sqrt{64} = 8 \quad \sqrt{121} = 11 \]
\[ \sqrt{9} = 3 \quad \sqrt{36} = 6 \quad \sqrt{81} = 9 \quad \sqrt{144} = 12 \]

Some square roots are not exact and have to be approximated. For example, \( \sqrt{12} \) is somewhere between \( \sqrt{9} = 3 \) and \( \sqrt{16} = 4 \). The \( \sqrt{12} \) appears to be very close to the middle, so we approximate to 3.5. To check it, we do 3.5 \( \cdot \) 3.5 and get 12.25. This means that 3.5 is a good approximation for \( \sqrt{12} \). Try these square roots.

**Examples:**
Approximate \( \sqrt{31} \)
\( \sqrt{25} < \sqrt{31} < \sqrt{36} \) (more than halfway)  
closer to 36. Try 5.6 \( \cdot \) 5.6 = 31.36

Approximate \( \sqrt{53} \)
\( \sqrt{49} < \sqrt{53} < \sqrt{64} \) (less than halfway)  
closer to 49. Try 7.3 \( \cdot \) 7.3 = 53.29

Imagine a special triangle with a 90º angle and the length of two short sides (called legs) given. To find the length of the longest side (called hypotenuse), use the Pythagorean Theorem, \( a^2 + b^2 = c^2 \). Such a triangle is called a right triangle.

For over 2400 years, the Pythagorean Theorem has been used to build great cities and support technological advancements. Some scholars believe that this theorem is 1000 years older than Pythagoras.

**Example:** Find the length of the missing side of the triangle.

\[ 6^2 + 8^2 = c^2 \quad 36 + 64 = c^2 \quad 100 = c^2 \quad \sqrt{100} = c \quad 10 = c \]

**Example:** Draw a right triangle having one leg that measures 12 inches and has a hypotenuse of 20 inches. Now find the length of the missing leg.

\[ 20^2 = x^2 + 12^2 \quad 400 = x^2 + 144 \quad x^2 = 256 \quad x = 16 \]
Name_________________________  

**Square Roots & Pythagorean Theorem**  
**Algebra 1**

**Answer the following.**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>$9 \cdot 9 = 81$</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>$12^2 = 144$</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>$\sqrt{49} = 7$</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>$\sqrt{56}$ is between the integers $7$ and $8$.</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>$\sqrt{100} = 10$</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>$\sqrt{69} = 13$</td>
<td></td>
</tr>
</tbody>
</table>
| 7. | True or False. $\sqrt{36 + 64} = \sqrt{36} + \sqrt{64}$  
False. $\sqrt{100} = 6 + 8$ |   |
| 8. | Draw a right triangle that has legs of 6 and 8, and has a hypotenuse of 10. |   |
| 9. | Find the missing side in the right triangle below. |   |
| 10. | Approximate $\sqrt{15}$ to tenths.  
$\sqrt{00} < \sqrt{15} < \sqrt{21}$  
closer to $\sqrt{21}$ so try 10.6  
10.7. Since $10.7^2 = 114.49$  
and $10.6^2 = 112.36$, the answer is 10.7. |   |
| 11. | Approximate $\sqrt{80}$ to tenths  
$\sqrt{69} < \sqrt{80} < \sqrt{96}$  
closer to $\sqrt{69}$ so try 13.4  
or 13.5  
13.4 $^2 = 179.56$; 13.4 closer.  
13.5 $^2 = 182.25$ |   |
| 12. | Approximate the length of the square’s diagonal to tenths.  
$12^2 + 12^2 = c^2$  
$144 + 144 = c^2$  
$c = \sqrt{288}$  
$a = 16.97$ or  
$a = 17$ |   |
| 13. | Approximate the width of the rectangle’s to tenths.  
$a^2 + 15^2 = 20^2$  
$a^2 + 225 = 400$  
$a^2 = 175$  
$a = \sqrt{175}$  
$a = 13.2$ |   |
| 14. | Which number is closer to $\sqrt{73}$? 8.6 or 8.3?  
$8.6^2 = 73.96$ and  
$8.3^2 = 68.89$  
8.6 is closest to $\sqrt{73}$. |   |
| 15. | A park is shaped like a square. The park area is $420 \text{ m}^2$.  
(a) What are the park’s dimensions?  
area = length $\cdot$ width  
$420 = x \cdot x$  
$420 = x^2$  
$x = \sqrt{420}$  
$\sqrt{420} = x$  
$20.5 = x$  
so square is $20.5 \text{ by } 20.5 \text{ m}$ |   |
| 16. | Choose $>, <$, or $=$.  
$\sqrt{25} \cdot \sqrt{121}$  
$\sqrt{3025} = 5 \cdot 11$  
$55 = 55$ |   |

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Center for Teacher Certification, ACC  
5  
Tutors with Vision Training, Packet 10
Packet 10– Square Roots and Pythagorean Theorem
Reflection Page

How did working through this packet help your skills?

How did working through this packet help your confidence regarding your math ability?

What else do you need in order to feel most confident about mastering square roots and the Pythagorean Theorem?

Other comments and notes:

This packet of information is only authorized to be used for tutoring purposes for Austin Community College students.