Name _____ Class _____ Date _____

Squares and Square Roots

Extension: Cube Roots

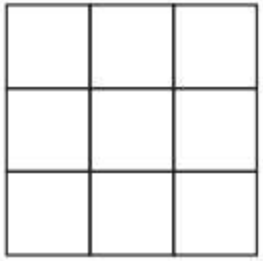
Essential question: *How do you evaluate square roots and cube roots?*

Warm UP WB: Pg. 87

MCC8.EE.2

1 EXPLORE **Finding the Square Root of Perfect Squares**

There are 9 square tiles used to make a square mosaic. There are 3 tiles along each side of the mosaic.



Another square mosaic is made using 64 square tiles. How many tiles are on each side of this mosaic?

A Use what you know about the mosaic made with 9 tiles to find the relationship between number of tiles on each side and the total number of square tiles.

_____

_____

B Use this relationship to find the number of tiles along the side of a square mosaic made of 64 square tiles.

between number of tiles on each side and the total number of square tiles.

B Use this relationship to find the number of tiles along the side of a square mosaic made of 64 square tiles.

C In this context, the total number of tiles is the number of tiles along each side of the mosaic squared. When the total number of tiles is 9, the number of tiles along a side is 3. Because $3^2 = 9$, we call 3 a *square root* of 9. This is written as $3 = \sqrt{9}$.

Use this notation to write the square root of 64: $\sqrt{64} =$

TRY THIS!

Evaluate each square root.

1a. $\sqrt{169}$ **1b.** $\sqrt{\frac{1}{16}}$ **1c.** $\sqrt{81}$ **1d.** $\sqrt{\frac{1}{400}}$

The **square root** of a positive number p is x if $x^2 = p$. There are two square roots for every positive number. For example, the square roots of 36 are 6 and -6 because $6^2 = 36$ and $(-6)^2 = 36$. The square roots of $\frac{1}{25}$ are $\frac{1}{5}$ and $-\frac{1}{5}$. You can write the square roots of $\frac{1}{25}$ as $\pm\frac{1}{5}$. The symbol $\sqrt{\ }$ indicates the positive, or **principal square root**.

Squares and Square Roots

Essential Question:
How do you evaluate square roots?

Standards:
MCC8.EE.2:
Use square root and cube rott symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squres and cube roots of small perfect cubes. Know that $\sqrt{2}$ is irrational.

Vocabulary

square root

principal square root

perfect square

Squares and Square Roots

Think about the relationship between the area of a square and the length of one of its sides.

area = 36 square units

side length = $\sqrt{36}$ = 6 units

A number that when multiplied by itself to form a product is the **square root** of that product. Taking the square root of a number is the inverse of squaring the number.

$6^2 = 36$ $\qquad\qquad$ $\sqrt{36} = 6$

Squares and Square Roots

Every positive number has two square roots, one positive and one negative. The radical symbol $\sqrt{\ }$ indicates the nonnegative or **principal square root**. The symbol $-\sqrt{\ }$ is used to indicate the negative square root.

The numbers 16, 36, and 49 are examples of perfect squares. A **perfect square** is a number that has integers as its square roots. Other perfect squares include 1, 4, 9, 25, 64, and 81.

Caution!

$\sqrt{-49}$ is not the same as $-\sqrt{49}$. A negative number has no real square root.

Squares and Square Roots

Additional Example: 1 Finding the Positive and Negative Square Roots of a Number

Find the two square roots of each number.

A. 49

$\sqrt{49} = 7$ *7 is a square root, since 7 • 7 = 49.*

$-\sqrt{49} = -7$ *–7 is also a square root, since –7 • –7 = 49.*

B. 100

$\sqrt{100} = 10$ *10 is a square root, since 10 • 10 = 100.*

$-\sqrt{100} = -10$ *–10 is also a square root, since –10 • –10 = 100.*

C. 225

$\sqrt{225} = 15$ *15 is a square root, since 15 • 15 = 225.*

$-\sqrt{225} = -15$ *–15 is also a square root, since –15 • –15 = 225.*

Squares and Square Roots

Check It Out: Example 1

Find the two square roots of each number.

A. 25

$\sqrt{25} = 5$ *5 is a square root, since 5 • 5 = 25.*

$-\sqrt{25} = -5$ *–5 is also a square root, since –5 • –5 = 25.*

B. 144

$\sqrt{144} = 12$ *12 is a square root, since 12 • 12 = 144.*

$-\sqrt{144} = -12$ *–12 is also a square root, since –12 • –12 = 144.*

C. 289

$\sqrt{289} = 17$ *17 is a square root, since 17 • 17 = 289.*

$-\sqrt{289} = -17$ *–17 is also a square root, since –17 • –17 = 289.*

B Use this relationship to find the number of tiles along the side of a square mosaic made of 64 square tiles.

C In this context, the total number of tiles is the number of tiles along each side of the mosaic squared. When the total number of tiles is 9, the number of tiles along a side is 3. Because $3^2 = 9$, we call 3 a *square root* of 9. This is written as $3 = \sqrt{9}$.

Use this notation to write the square root of 64: $\sqrt{64} =$

TRY THIS!

Evaluate each square root.

1a. $\sqrt{169}$ **1b.** $\sqrt{\frac{1}{16}}$ **1c.** $\sqrt{81}$ **1d.** $\sqrt{\frac{1}{400}}$

The **square root** of a positive number p is x if $x^2 = p$. There are two square roots for every positive number. For example, the square roots of 36 are 6 and -6 because $6^2 = 36$ and $(-6)^2 = 36$. The square roots of $\frac{1}{25}$ are $\frac{1}{5}$ and $-\frac{1}{5}$. You can write the square roots of $\frac{1}{25}$ as $\pm\frac{1}{5}$. The symbol $\sqrt{\ }$ indicates the positive, or **principal square root**.

A number that is a **perfect square** has square roots that are integers. The number 81 is a perfect square because its square roots are 9 and -9.

Additional Example 2: *Application*

A square window has an area of 169 square inches. How wide is the window?

Write and solve an equation to find the area of the window.

$13^2 = 169$

So $\sqrt{169} = 13$.

Use the positive square root; a negative length has no meaning. The window is 13 inches wide.

Remember!

The area of a square is s^2, where s is the length of a side.

Check It Out: Example 2

A square shaped kitchen table has an area of 16 square feet. Will it fit through a van door that has a 5 foot wide opening?

Write and solve an equation to find the area of the kitchen table

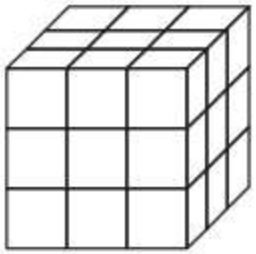
$$\sqrt{16} = 4$$

Use the positive square root; a negative length has no meaning. So the table is 4 feet wide, which is less than 5 feet, so it will fit through the van door.

MCC8.EE.2

2 EXPLORE Finding the Cube Root

A cube shaped toy is made of 27 small cubes.
There are 3 cubes along each edge of the toy.



WB: Pg. 88

Another cube shaped toy is made using 8 small cubes.
How many small cubes are on each edge of this toy?

A Use what you know about the toy made with 27 small cubes to find the relationship between number of cubes on each edge and the total number of cubes.

B Use this relationship to find the number of small cubes along each edge of a toy made of 8 small cubes.

C In this situation, the total number of small cubes is the number of small cubes along each edge of the toy cube. When the total number of small cubes is 27, the number of small cubes along each edge is 3. Because $3^3 = 27$, we call 3 a *cube root* of 27. This is written as $\sqrt[3]{27} = 3$.

Use this notation to write the cube root of 8: $\sqrt[3]{8} =$ ____

$3^3 = 27$, we call 3 a *cube root* of 27. This is written as $\sqrt[3]{27} = 3$.

Use this notation to write the cube root of 8: $\sqrt[3]{8} =$ ____

REFLECT

2a. The product of 3 equal positive factors is positive / negative.

2b. The product of 3 equal negative factors is positive / negative.

2c. Use your answers to **2a** and **2b** to explain when there is only one cube root of a positive number.

_____

_____

_____

TRY THIS!

Evaluate each cube root.

2d. $\sqrt[3]{125}$ _____

2e. $\sqrt[3]{\frac{1}{8}}$ _____

2f. $\sqrt[3]{1000}$ _____

2g. $\sqrt[3]{\frac{1}{343}}$ _____

Additional Example 3A: Evaluating Expressions Involving Square Roots

Simplify the expression.

$3\sqrt{36} + 7$

$3\sqrt{36} + 7 = 3(6) + 7$ *Evaluate the square root.*

$= 18 + 7$ *Multiply.*

$= 25$ *Add.*

Additional Example 3B: Evaluating Expressions Involving Square Roots

Simplify the expression.

$$\sqrt{\frac{25}{16}} + \frac{3}{4}$$

$$\sqrt{\frac{25}{16}} + \frac{3}{4} = \sqrt{1.5625} + \frac{3}{4}$$

$\sqrt{\frac{25}{16}} = 1.5625.$

$$= 1.25 + \frac{3}{4}$$

Evaluate the square roots.

$$= 2$$

Add.

Check It Out: Example 3A

Simplify the expression.

$2\sqrt{25} + 4$

$2\sqrt{25} + 4 = 2(5) + 4$ *Evaluate the square root.*

$= 10 + 4$ *Multiply.*

$= 14$ *Add.*

Check It Out: Example 3B

Simplify the expression.

$$\sqrt{\frac{18}{2}} + \frac{1}{4}$$

$$\sqrt{\frac{18}{2}} + \frac{1}{4} = \sqrt{9} + \frac{1}{4} \qquad \sqrt{\frac{18}{2}} = 9.$$

$$= 3 + \frac{1}{4} \qquad \textit{Evaluate the square roots.}$$

$$= 3\frac{1}{4} \qquad \textit{Add.}$$

125 is a perfect cube because its cube root is 5.

MCC8.EE.2

3 EXAMPLE Solving Equations Using Square Roots and Cube Roots

Solve each equation for *x*.

A $x^2 = 121$

$\sqrt{x^2} = \sqrt{121}$ *Solve for x by taking the square root of both sides.*

$x = \sqrt{121}$ *Think: What number squared equals 121?*

$x = \pm$ *Use ± to show both square roots.*

The solutions are _____ and _____.

B $x^2 = \frac{16}{169}$

$\sqrt{x^2} = \sqrt{\frac{16}{169}}$ *Solve for x by taking the square root of both sides.*

$x = \sqrt{\frac{16}{169}}$ *Think: What number squared equals $\frac{16}{169}$?*

$x = \pm \frac{4}{\quad}$ *Use ± to show both square roots.*

The solutions are _____ and _____.

C $729 = x^3$

$\sqrt[3]{729} = \sqrt[3]{x^3}$ *Solve for x by taking the cube root of both sides.*

$x = \pm \frac{4}{\square}$ *Use ± to show both square roots.*

The solutions are _____ and _____.

C $729 = x^3$

$\sqrt[3]{729} = \sqrt[3]{x^3}$ *Solve for x by taking the cube root of both sides.*

$\sqrt[3]{729} = x$ *Think: What number cubed equals 729?*

$\square = x$

The solution is _____.

D $x^3 = \frac{8}{125}$

$\sqrt[3]{x^3} = \sqrt[3]{\frac{8}{125}}$ *Solve for x by taking the cube root of both sides.*

$x = \sqrt[3]{\frac{8}{125}}$ *Think: What number cubed equals $\frac{8}{125}$?*

$x = \frac{2}{\square}$

The solution is _____.

Find the square roots of each number.

1. 144 _____ **2.** 256 _____ **3.** $\frac{1}{81}$ _____

4. $\frac{49}{900}$ _____ **5.** 400 _____ **6.** $\frac{1}{100}$ _____

Find the cube root of each number.

7. 216 _____ **8.** 8000 _____ **9.** $\frac{27}{125}$ _____

10. $\frac{1}{27}$ _____ **11.** $\frac{27}{64}$ _____ **12.** 512 _____

Simplify each expression.

13. $\sqrt{16} + \sqrt{25}$ _____ **14.** $\sqrt[3]{125} + 10$ _____ **15.** $\sqrt{25} + 10$ _____

16. $8 - \sqrt{64}$ _____ **17.** $\sqrt[3]{\frac{16}{2}} + 1$ _____ **18.** $\sqrt{\frac{16}{4}} + \sqrt{4}$ _____

19. The foyer of Ann's house is a square with an area of 36 square feet. What is the length of each side of the foyer?

_____

20. A chessboard has 32 black squares and 32 white squares arranged in a square. How many squares are along each side of the chessboard?

_____

21. A cubic aquarium holds 27 cubic feet of water. What is the length of each edge of the cube?

Squares and Square Roots

Lesson Quiz

Find the two square roots of each number.

1. 81 ±9

2. 2500 ±50

Evaluate each expression.

3. $3\sqrt{16} + 1$ 13

4. $7\sqrt{9} - 2\sqrt{49}$ 7

5. Ms. Estefan wants to put a fence around 3 sides of a square garden that has an area of 225 ft^2. How much fencing does she need?

45 ft