

SIMPLIFY RADICAL EXPRESSIONS

By DataWORKS Educational Research

Learning Objective

We will simplify radical expressions.

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What are we going to do?

Activate Prior Knowledge

What is the value of each expression below?

1. $\sqrt{49} = 7$

2. $\sqrt{36} = 6$

Make Connection

Students, you already know how to identify the value of square roots. Now, we will use the value of square roots to simplify radical expressions.

Concept Development

A **square root** is the inverse operation of squaring a number.

- Square roots are shown with a radical sign $\sqrt{\quad}$.
- The number under the radical sign is called the **radicand**.

Example: Inverse operations

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

$$\sqrt{36} \text{ "the square root of 36"}$$

↑
radicand

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How do you read $\sqrt{24}$?

Which radical expression is equivalent to $\sqrt{2 \cdot 3 \cdot 5}$? How do you know?

A $\sqrt{11}$ B $\sqrt{30}$

Which square root is factored correctly?

A $\sqrt{3} \cdot \sqrt{3} - 3$ B $\sqrt{3} \cdot \sqrt{3} - 9$

In your own words, what is a square root?

"A square root is _____."

The **root of a number** equals the product of the prime factors of the radicand.

$$\sqrt{a \cdot b} = \sqrt{a} \cdot \sqrt{b}$$

If the values of **a** and **b** are equal, then: $\sqrt{a \cdot a} = \sqrt{a} \cdot \sqrt{a} = a$

Example: $\sqrt{2 \cdot 2} = \sqrt{2} \cdot \sqrt{2} = \sqrt{4} = 2$

Examples: prime factorization of radicand

$$\sqrt{36} = \sqrt{4 \cdot 9} = \sqrt{2 \cdot 2 \cdot 3 \cdot 3} = \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{3} \cdot \sqrt{3} = 2 \cdot 3 = 6$$

$$\sqrt{12} = \sqrt{4 \cdot 3} = \sqrt{2 \cdot 2 \cdot 3} = \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{3} = 2 \cdot \sqrt{3} = 2\sqrt{3}$$

Vocabulary

¹ same

A **square root** is the inverse operation of squaring a number.
The **root of a number** equals the product of the prime factors of the radicand.

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- How did I/you find the prime factors of the radical expression?
- How did I/you simplify the radical expression?

Simplify radical expressions.

- Read the radical expression. Identify the radicand. (underline)
- Find the prime factors of the radical expression.
 - Rewrite the radical expression as the product of the prime factors of the radicand.
- Simplify the radical expression.
- Interpret your solution. "The most simplified form of _____ is _____."

$\sqrt{36}$ "the square root of 36"
 \uparrow radicand

$$1. \sqrt{40} = \sqrt{2 \cdot 2 \cdot 2 \cdot 5} = \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{5} = 2 \cdot \sqrt{10} =$$

40
4 • 10
2 • 2 • 2 • 5

The most simplified form of $\sqrt{40}$ is $2\sqrt{10}$.

$$2. \sqrt{44} = \sqrt{2 \cdot 2 \cdot 11} = \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{11} = 2 \cdot \sqrt{11} =$$

44
4 • 11
2 • 2 • 11

The most simplified form of $\sqrt{44}$ is $2\sqrt{11}$.

$$3. \sqrt{135} = \sqrt{3 \cdot 3 \cdot 3 \cdot 5} = \sqrt{3} \cdot \sqrt{3} \cdot \sqrt{3} \cdot \sqrt{5} = 3 \cdot \sqrt{15} =$$

135
9 • 15
3 • 3 • 3 • 5

The most simplified form of $\sqrt{135}$ is $3\sqrt{15}$.

$$4. \sqrt{90} = \sqrt{3 \cdot 3 \cdot 2 \cdot 5} = \sqrt{3} \cdot \sqrt{3} \cdot \sqrt{2} \cdot \sqrt{5} = 3 \cdot \sqrt{10} =$$

90
9 • 10 =
3 • 3 • 2 • 5

The most simplified form of $\sqrt{90}$ is $3\sqrt{10}$.

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CFU

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- How did I/you simplify the radical expression?

Simplify radical expressions.

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- Find the prime factors of the radical expression.
 - Rewrite the radical expression as the product of the prime factors of the radicand.
- Simplify the radical expression.
- Interpret your solution. *"The most simplified form of _____ is _____."*

$\sqrt{36}$ "the square root of 36"
↑
radicand

$$5. \sqrt{175} = \sqrt{5 \cdot 5 \cdot 7} = \sqrt{5} \cdot \sqrt{5} \cdot \sqrt{7} = 5 \cdot \sqrt{7} =$$

175
25 • 7
5 • 5 • 7

The most simplified form of $\sqrt{175}$ is $5\sqrt{7}$.

$$6. \sqrt{275} = \sqrt{5 \cdot 5 \cdot 11} = \sqrt{5} \cdot \sqrt{5} \cdot \sqrt{11} = 5 \cdot \sqrt{11} =$$

275
25 • 11
5 • 5 • 11

The most simplified form of $\sqrt{275}$ is $5\sqrt{11}$.

$$7. \sqrt{108} = \sqrt{3 \cdot 3 \cdot 2 \cdot 2 \cdot 3} = \sqrt{3} \cdot \sqrt{3} \cdot \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{3} =$$

108
9 • 12
9 • 4 • 3
3 • 3 • 2 • 2 • 3

$3 \cdot 2 \cdot \sqrt{3} = 6 \cdot \sqrt{3}$

The most simplified form of $\sqrt{108}$ is $6\sqrt{3}$.

$$8. \sqrt{72} = \sqrt{3 \cdot 3 \cdot 2 \cdot 2 \cdot 2} = \sqrt{3} \cdot \sqrt{3} \cdot \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{2} =$$

72
9 • 8
9 • 4 • 2
3 • 3 • 2 • 2 • 2

$3 \cdot 2 \cdot \sqrt{2} = 6 \cdot \sqrt{2}$

The most simplified form of $\sqrt{72}$ is $6\sqrt{2}$.

Skill Development/Guided Practice (continued)

A **square root** is the inverse operation of squaring a number.
The **root of a number** equals the product of the prime factors of the radicand.

CFU

- How did I/you find the prime factors of the radical expression?
- How did I/you simplify the radical expression?

Simplify radical expressions.

- Read the radical expression. Identify the radicand. (underline)
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 - Rewrite the radical expression as the product of the prime factors of the radicand.
- Simplify the radical expression.
- Interpret your solution. "The most simplified form of _____ is _____."

$\sqrt{36}$ "the square root of 36"
↑
radicand

9. $\sqrt{42} =$

$$\begin{array}{l} 42 \\ 6 \cdot 7 \\ 2 \cdot 3 \cdot 7 \end{array}$$

The most simplified form of $\sqrt{42}$ is $\sqrt{42}$.

10. $\sqrt{30} =$

$$\begin{array}{l} 30 \\ 6 \cdot 5 \\ 3 \cdot 2 \cdot 5 \end{array}$$

The most simplified form of $\sqrt{30}$ is $\sqrt{30}$.

A **square root** is the inverse operation of squaring a number.

The **root of a number** equals the product of the prime factors of the radicand.

1 Simplifying radical expressions will help you estimate values more easily.

Approximate
values of some
square roots

$$\sqrt{2} \approx 1.41$$

$$\sqrt{3} \approx 1.73$$

$$\sqrt{5} \approx 2.24$$

What is the approximate decimal value of $\sqrt{200}$?

$$\sqrt{200} = \sqrt{100 \cdot 2} = \sqrt{100} \cdot \sqrt{2} = 10 \cdot \sqrt{2} = 10\sqrt{2}$$

$$10\sqrt{2} \approx 10 \cdot 1.41 \approx 14.1$$

The approximate value of $\sqrt{200}$ is 14.1.

2 Simplifying radical expressions will help you do well on tests.

Sample Test Question:

28. $\sqrt{225} =$

- A 15
- B 25
- C 35
- D 45

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Does anyone else have another reason why it is relevant to simplify radical expressions? (Pair-Share) Why is it relevant to simplify radical expressions? You may give one of my reasons or one of your own. Which reason is more relevant to you? Why?

Closure

A **square root** is the inverse operation of squaring a number.
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Skill Closure

Simplify radical expressions.

- 1 Read the radical expression. Identify the radicand. (underline)
- 2 Find the prime factors of the radical expression.
 - a Rewrite the radical expression as the product of the prime factors of the radicand.
- 3 Simplify the radical expression.
- 4 Interpret your solution. "The most simplified form of _____ is _____."

$$1. \sqrt{63} = \sqrt{3 \cdot 3 \cdot 7} = \sqrt{3} \cdot \sqrt{3} \cdot \sqrt{7} = 3 \cdot \sqrt{7} =$$

63
9 • 7
3 • 3 • 7

The most simplified form of $\sqrt{63}$ is $3\sqrt{7}$.

$$2. \sqrt{81} = \sqrt{3 \cdot 3 \cdot 3 \cdot 3} = \sqrt{3} \cdot \sqrt{3} \cdot \sqrt{3} \cdot \sqrt{3} = 3 \cdot 3 = 9$$

81
9 • 9
3 • 3 • 3 • 3

The most simplified form of $\sqrt{81}$ is 9.

Constructed Response Closure

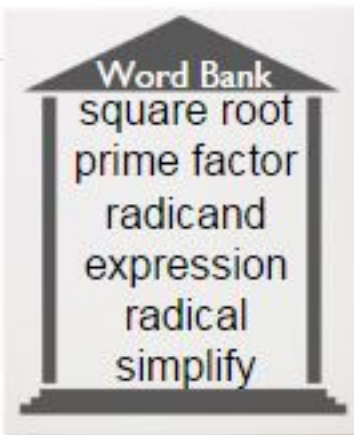
Anna thinks that $\sqrt{50} = 5$. Is Anna correct? Why or why not?

Anna is incorrect. 50 factors as $5 \cdot 5 \cdot 2$, so $\sqrt{50} = 5\sqrt{2}$

Summary Closure

What did you learn today about simplifying radical expressions? (Pair-Share)

Use words from the word bank.



Independent Practice

A **square root** is the inverse operation of squaring a number.
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$$\sqrt{36} \quad \text{"the square root of 36"}$$

↑ radicand

Simplify radical expressions.

- 1 Read the radical expression. Identify the radicand. (underline)
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- 3 Simplify the radical expression.
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$$1. \quad \sqrt{\underline{54}} = \sqrt{3 \cdot 3 \cdot 3 \cdot 2} = \sqrt{3} \cdot \sqrt{3} \cdot \sqrt{3} \cdot \sqrt{2} = 3 \cdot \sqrt{2} \cdot \sqrt{3} = 3 \cdot \sqrt{6}$$

$\frac{54}{9 \cdot 6}$
 $3 \cdot 3 \cdot 3 \cdot 2$

The most simplified form of $\sqrt{54}$ is $3\sqrt{6}$.

$$2. \quad \sqrt{\underline{100}} = \sqrt{5 \cdot 5 \cdot 2 \cdot 2} = \sqrt{5} \cdot \sqrt{5} \cdot \sqrt{2} \cdot \sqrt{2} = 2 \cdot 5 = 10$$

$\frac{100}{25 \cdot 4}$
 $5 \cdot 5 \cdot 2 \cdot 2$

The most simplified form of $\sqrt{100}$ is 10.

$$3. \quad \sqrt{\underline{48}} = \sqrt{3 \cdot 2 \cdot 2 \cdot 2 \cdot 2} = \sqrt{3} \cdot \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{2} = 4 \cdot \sqrt{3}$$

$\frac{48}{6 \cdot 8}$
 $3 \cdot 2 \cdot 2 \cdot 2 \cdot 2$

The most simplified form of $\sqrt{48}$ is $4\sqrt{3}$.

$$4. \quad \sqrt{\underline{35}} = 5 \cdot 7 =$$

The most simplified form of $\sqrt{35}$ is $\sqrt{35}$.

A **square root** is the inverse operation of squaring a number.
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$\sqrt{36}$ "the square root of 36"
 ↑ radicand

Simplify radical expressions.

- 1 Read the radical expression. Identify the radicand. (underline)
- 2 Find the prime factors of the radical expression.
 - a Rewrite the radical expression as the product of the prime factors of the radicand.
- 3 Simplify the radical expression.
- 4 Interpret your solution. "The most simplified form of _____ is _____."

1. $\sqrt{60} = \sqrt{2 \cdot 2 \cdot 3 \cdot 5} = \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{3} \cdot \sqrt{5} = 2 \cdot \sqrt{15} =$
 $\begin{matrix} 60 \\ 4 \cdot 15 \\ 2 \cdot 2 \cdot 3 \cdot 5 \end{matrix}$

The most simplified form of $\sqrt{60}$ is $2\sqrt{15}$.

2. $\sqrt{225} = \sqrt{5 \cdot 5 \cdot 3 \cdot 3} = \sqrt{5} \cdot \sqrt{5} \cdot \sqrt{3} \cdot \sqrt{3} = 5 \cdot 3 = 15$
 $\begin{matrix} 225 \\ 25 \cdot 9 \\ 5 \cdot 5 \cdot 3 \cdot 3 \end{matrix}$

The most simplified form of $\sqrt{225}$ is 15.

3. $\sqrt{96} = \sqrt{2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 3} = \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{3}$
 $\begin{matrix} 96 \\ 4 \cdot 4 \cdot 6 \\ 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 3 \end{matrix} = 2 \cdot 2 \cdot \sqrt{3 \cdot 2} = 4 \cdot \sqrt{6}$

The most simplified form of $\sqrt{96}$ is $4\sqrt{6}$.

4. $\sqrt{66} =$
 $\begin{matrix} 66 \\ 6 \cdot 11 \\ 3 \cdot 2 \cdot 11 \end{matrix}$

The most simplified form of $\sqrt{66}$ is $\sqrt{66}$.

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$\sqrt{36}$ "the square root of 36"
 ↑ radicand

Simplify radical expressions.

- 1 Read the radical expression. Identify the radicand. (underline)
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 - a Rewrite the radical expression as the product of the prime factors of the radicand.
- 3 Simplify the radical expression.
- 4 Interpret your solution. "The most simplified form of _____ is _____."

$$1. \sqrt{99} = \sqrt{3 \cdot 3 \cdot 11} = \sqrt{3} \cdot \sqrt{3} \cdot \sqrt{11} = 3 \cdot \sqrt{11} =$$

$$\begin{array}{l} 99 \\ 9 \cdot 11 \\ 3 \cdot 3 \cdot 11 \end{array}$$

The most simplified form of $\sqrt{99}$ is $3\sqrt{11}$.

$$2. \sqrt{256} = \sqrt{2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2} =$$

$$\begin{array}{l} 256 \quad \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{2} = \\ 4 \cdot 4 \cdot 4 \cdot 4 \quad 2 \cdot 2 \cdot 2 \cdot 2 = 16 \\ 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \end{array}$$

The most simplified form of $\sqrt{256}$ is 16.

$$3. \sqrt{324} = \sqrt{3 \cdot 3 \cdot 3 \cdot 3 \cdot 2 \cdot 2} = \sqrt{3} \cdot \sqrt{3} \cdot \sqrt{3} \cdot \sqrt{3} \cdot \sqrt{2} \cdot \sqrt{2} =$$

$$\begin{array}{l} 324 \\ 9 \cdot 36 \\ 9 \cdot 9 \cdot 4 \\ 3 \cdot 3 \cdot 3 \cdot 3 \cdot 2 \cdot 2 \end{array}$$

$$= 3 \cdot 3 \cdot 2 = 18$$

The most simplified form of $\sqrt{324}$ is 18.

$$4. \sqrt{200} = \sqrt{5 \cdot 5 \cdot 2 \cdot 2 \cdot 2} = \sqrt{5} \cdot \sqrt{5} \cdot \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{2} =$$

$$\begin{array}{l} 200 \\ 25 \cdot 8 \\ 5 \cdot 5 \cdot 4 \cdot 2 \\ 5 \cdot 5 \cdot 2 \cdot 2 \cdot 2 \end{array}$$

$$5 \cdot 2 \cdot \sqrt{2} = 10 \cdot \sqrt{2}$$

The most simplified form of $\sqrt{200}$ is $10\sqrt{2}$.

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$$\sqrt{36} \quad \text{"the square root of 36"}$$

↑
radicand

Simplify radical expressions.

- 1 Read the radical expression. Identify the radicand. (underline)
- 2 Find the prime factors of the radical expression.
 - a Rewrite the radical expression as the product of the prime factors of the radicand.
- 3 Simplify the radical expression.
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$$1. \sqrt{75} = \sqrt{5 \cdot 5 \cdot 3} = \sqrt{5} \cdot \sqrt{5} \cdot \sqrt{3} = 5 \cdot \sqrt{3} =$$

$$\begin{array}{r} 75 \\ 25 \cdot 3 \\ 5 \cdot 5 \cdot 3 \end{array}$$

The most simplified form of $\sqrt{75}$ is $5\sqrt{3}$.

$$2. \sqrt{360} = \sqrt{3 \cdot 3 \cdot 2 \cdot 2 \cdot 2 \cdot 5} =$$

$$\begin{array}{r} 360 \\ 9 \cdot 40 \\ 3 \cdot 3 \cdot 2 \cdot 2 \cdot 2 \cdot 5 \end{array}$$

$$\sqrt{3} \cdot \sqrt{3} \cdot \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{5} =$$

$$3 \cdot 2 \cdot \sqrt{2 \cdot 5} = 6 \cdot \sqrt{10} =$$

The most simplified form of $\sqrt{360}$ is $6\sqrt{10}$.

$$3. \sqrt{400} = \sqrt{5 \cdot 5 \cdot 2 \cdot 2 \cdot 2 \cdot 2} = \sqrt{5} \cdot \sqrt{5} \cdot \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{2} =$$

$$\begin{array}{r} 400 \\ 25 \cdot 16 \\ 5 \cdot 5 \cdot 4 \cdot 4 \\ 5 \cdot 5 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \end{array}$$

$$5 \cdot 2 \cdot 2 = 20$$

The most simplified form of $\sqrt{400}$ is 20 .

$$4. \sqrt{180} = \sqrt{3 \cdot 3 \cdot 2 \cdot 2 \cdot 5} = \sqrt{3} \cdot \sqrt{3} \cdot \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{5} =$$

$$\begin{array}{r} 180 \\ 9 \cdot 20 \\ 9 \cdot 4 \cdot 5 \\ 3 \cdot 3 \cdot 2 \cdot 2 \cdot 5 \end{array}$$

$$3 \cdot 2 \cdot \sqrt{5} = 6 \cdot \sqrt{5} =$$

The most simplified form of $\sqrt{180}$ is $6\sqrt{5}$.