

Module 4: Radical Expressions

Topic 1 Content: Simplifying Square Roots of Algebraic Expressions

Introduction



Today's Lesson

- You will apply the Product Property of Radicals to simplify square roots of monomial expressions.

Hi there! I'm so glad you could join me for this lesson in Algebra I, where you will learn how to simplify square roots of monomial expressions. The Product Property of Radicals will be the key to successfully completing this lesson.

Module 4: Radical Expressions

Topic 1 Content: Simplifying Square Roots of Algebraic Expressions

Simplifying Square Roots of Algebraic Expressions

The graphic features a dark background with faint chalkboard-style mathematical symbols. At the top, a teal rounded rectangle contains the title "SIMPLIFYING SQUARE ROOTS OF ALGEBRAIC EXPRESSIONS" in white, bold, uppercase letters. Below this, a yellow text prompt reads "Click the Examples Below to Learn More". Three magenta rounded rectangles are arranged in two rows: "Example One" and "Self-Check" in the top row, and "Example Two" in the bottom row. In the bottom right corner, there is a 3D rendering of a white rectangular prism with a smaller white cube resting on top of it.

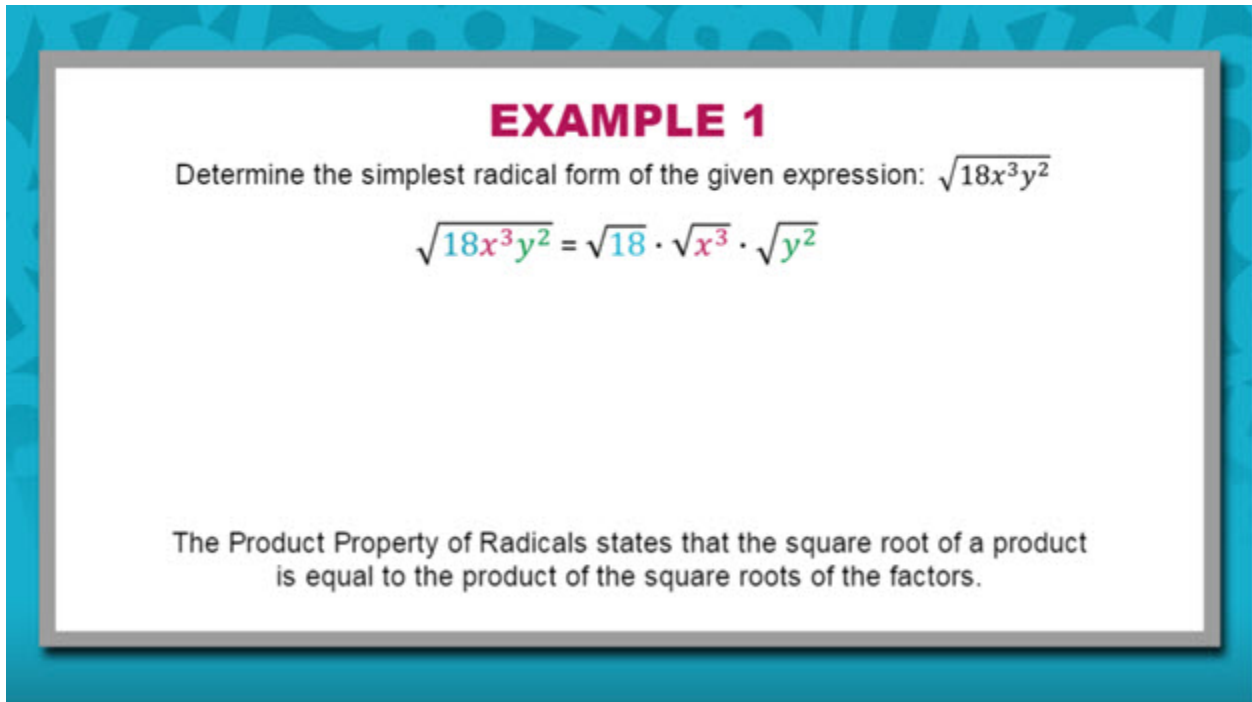
Click the examples below to learn more.

- Example One
- Example Two
- Self-Check

Module 4: Radical Expressions

Topic 1 Content: Simplifying Square Roots of Algebraic Expressions

Example 1



EXAMPLE 1

Determine the simplest radical form of the given expression: $\sqrt{18x^3y^2}$

$$\sqrt{18x^3y^2} = \sqrt{18} \cdot \sqrt{x^3} \cdot \sqrt{y^2}$$

The Product Property of Radicals states that the square root of a product is equal to the product of the square roots of the factors.

Determine the simplest radical form of the given expression.

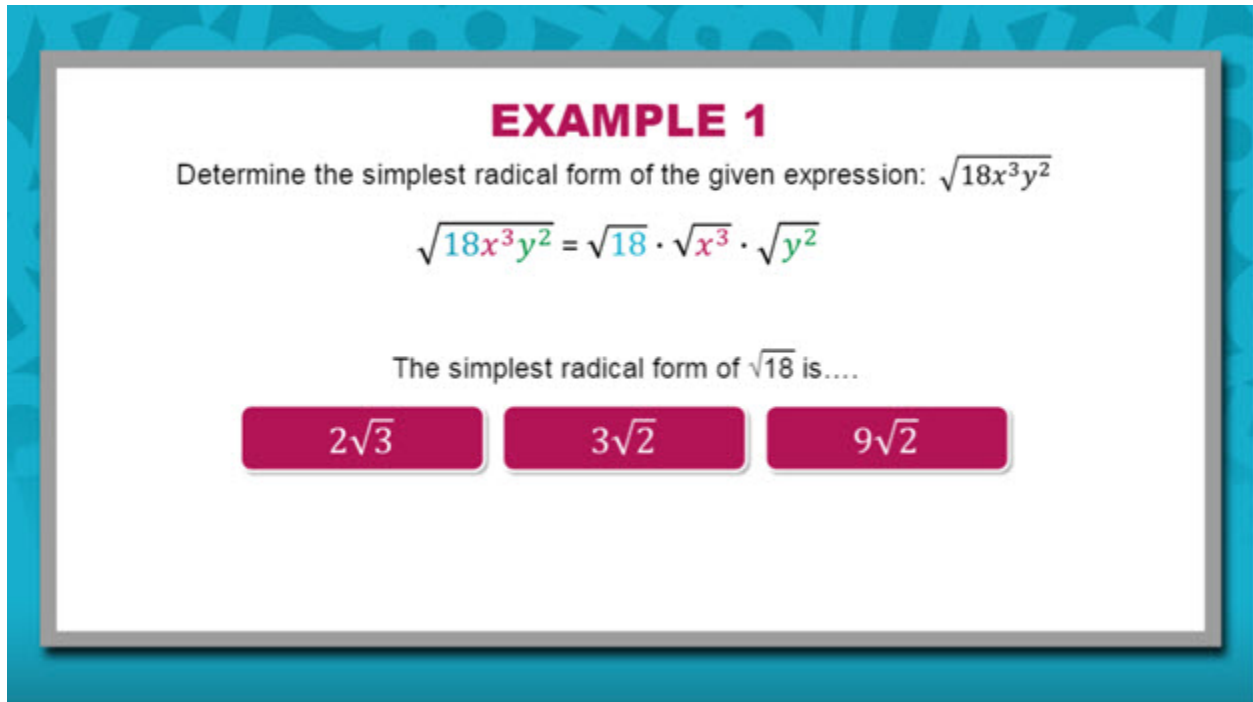
$$\sqrt{18x^3y^2}$$

The radicand of the given expression is a monomial consisting of the product of 18, x^3 , and y^2 . Recall that the Product Property of Radicals states that the square root of a product is equal to the product of the square roots of the factors. This means that $\sqrt{18x^3y^2}$ can be represented as the product of $\sqrt{18}$, $\sqrt{x^3}$, and $\sqrt{y^2}$.

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Example 1 (continued)



EXAMPLE 1

Determine the simplest radical form of the given expression: $\sqrt{18x^3y^2}$

$$\sqrt{18x^3y^2} = \sqrt{18} \cdot \sqrt{x^3} \cdot \sqrt{y^2}$$

The simplest radical form of $\sqrt{18}$ is....

$2\sqrt{3}$ $3\sqrt{2}$ $9\sqrt{2}$

The next step in simplifying the expression is to simplify each square root factor. Begin with $\sqrt{18}$.

The simplest radical form of $\sqrt{18}$ is ...

- A) $2\sqrt{3}$
- B) $3\sqrt{2}$
- C) $9\sqrt{2}$

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Topic 1 Content: Simplifying Square Roots of Algebraic Expressions

Example 1 (continued)

EXAMPLE 1

Determine the simplest radical form of the given expression: $\sqrt{18x^3y^2}$

$$\begin{aligned}\sqrt{18x^3y^2} &= \sqrt{18} \cdot \sqrt{x^3} \cdot \sqrt{y^2} \\ &= 3\sqrt{2}\end{aligned}$$

The simplest radical form of $\sqrt{18}$ is $3\sqrt{2}$.

$3\sqrt{2}$

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$$\begin{aligned}\sqrt{18x^3y^2} &= \sqrt{18} \cdot \sqrt{x^3} \cdot \sqrt{y^2} \\ &= 3\sqrt{2}\end{aligned}$$

The simplest radical form of $\sqrt{18}$ is $3\sqrt{2}$.

You can now represent $\sqrt{18}$ as $3\sqrt{2}$.

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Example 1 (continued)

EXAMPLE 1

Determine the simplest radical form of the given expression: $\sqrt{18x^3y^2}$

$\sqrt{18} = \sqrt{3 \cdot 3 \cdot 2}$	Complete the prime factorization of 18.
$= \sqrt{3^2 \cdot 2}$	Represent multiple factors as a square term.
$= \sqrt{3^2} \cdot \sqrt{2}$	Apply the Product Property of Radicals.
$= 3 \cdot \sqrt{2}$	Simplify the perfect square.
$= 3\sqrt{2}$	Simplify the expression.

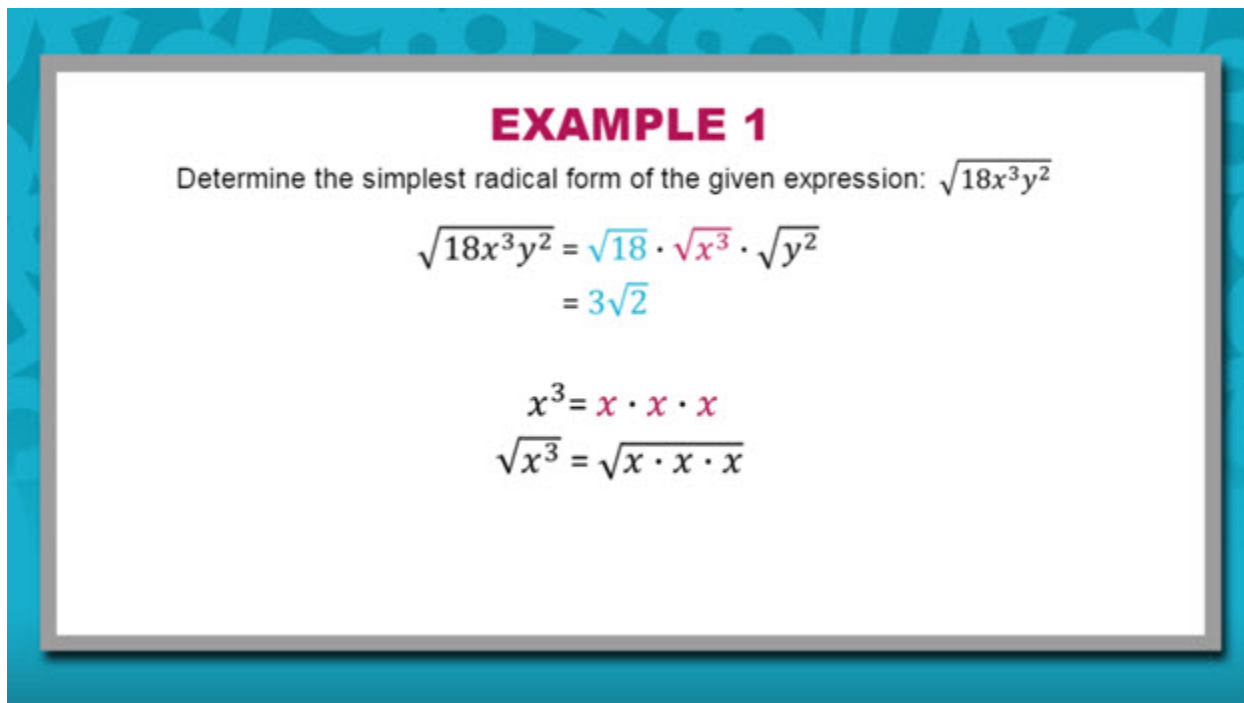
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$\sqrt{18} = \sqrt{3 \cdot 3 \cdot 2}$	Complete the prime factorization of 18.
$= \sqrt{3^2 \cdot 2}$	Represent multiple factors as a square term.
$= \sqrt{3^2} \cdot \sqrt{2}$	Apply the Product Property of Radicals.
$= 3 \cdot \sqrt{2}$	Simplify the perfect square.
$= 3\sqrt{2}$	Simplify the expression.

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Example 1 (continued)



EXAMPLE 1

Determine the simplest radical form of the given expression: $\sqrt{18x^3y^2}$

$$\begin{aligned}\sqrt{18x^3y^2} &= \sqrt{18} \cdot \sqrt{x^3} \cdot \sqrt{y^2} \\ &= 3\sqrt{2}\end{aligned}$$
$$x^3 = x \cdot x \cdot x$$
$$\sqrt{x^3} = \sqrt{x \cdot x \cdot x}$$

Now that you know that $\sqrt{18}$ simplifies to $3\sqrt{2}$, you can move on and simplify $\sqrt{x^3}$. Even though the radicand is an algebraic expression, the process to simplifying it is the same as simplifying a numerical expression.

Begin by representing x^3 as the product of its prime factors. $x^3 = x \cdot x \cdot x$

Now that you know the prime factorization of x^3 , you can represent $\sqrt{x^3}$ as $\sqrt{x \cdot x \cdot x}$.

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Topic 1 Content: Simplifying Square Roots of Algebraic Expressions

Example 1 (continued)

EXAMPLE 1

Determine the simplest radical form of the given expression: $\sqrt{18x^3y^2}$

$\sqrt{x^3} = \sqrt{x \cdot x \cdot x}$	<p style="color: #c00000;">Identify multiple factors that can be rewritten as a square term.</p>
$= \sqrt{x^2 \cdot x}$	<p style="color: #c00000;">Apply the Product Property of Radicals.</p>
$= \sqrt{x^2} \cdot \sqrt{x}$	<p style="color: #c00000;">Simplify the expression by simplifying each square root factor.</p>
$= x \cdot \sqrt{x}$	<p style="color: #c00000;">Simplify the expression.</p>
$= x\sqrt{x}$	

The next step is to identify multiple factors that can be rewritten as a square term; $x \cdot x$ can be represented as x^2 .

So, $\sqrt{x^3}$ can be represented as $\sqrt{x^2 \cdot x}$.

Next, apply the Product Property of Radicals to represent $\sqrt{x^2 \cdot x}$ as $\sqrt{x^2} \cdot \sqrt{x}$.

Now, simplify the expression. Begin with the first square root factor. Recall that squaring a term and finding the square root of a term are inverse operations. This means that $\sqrt{x^2}$ is x . Move on to the second square root factor. The radicand contains no perfect square factors other than 1. Therefore, \sqrt{x} is in simplest radical form.

So, $\sqrt{x^3}$ can be represented as $x \cdot \sqrt{x}$. After simplifying the expression, you find that the simplest radical form of $\sqrt{x^3}$ is $x\sqrt{x}$.

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Example 1 (continued)

EXAMPLE 1

Determine the simplest radical form of the given expression: $\sqrt{18x^3y^2}$

$$\begin{aligned}\sqrt{18x^3y^2} &= \sqrt{18} \cdot \sqrt{x^3} \cdot \sqrt{y^2} \\ &= 3\sqrt{2} \cdot x\sqrt{x}\end{aligned}$$

$$\begin{aligned}\sqrt{18x^3y^2} &= \sqrt{18} \cdot \sqrt{x^3} \cdot \sqrt{y^2} \\ &= 3\sqrt{2} \cdot x\sqrt{x}\end{aligned}$$

In the expression, you can now represent $\sqrt{x^3}$ as $x\sqrt{x}$.

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Topic 1 Content: Simplifying Square Roots of Algebraic Expressions

Example 1 (continued)

EXAMPLE 1

Determine the simplest radical form of the given expression: $\sqrt{18x^3y^2}$

$$\begin{aligned}\sqrt{18x^3y^2} &= \sqrt{18} \cdot \sqrt{x^3} \cdot \sqrt{y^2} \\ &= 3\sqrt{2} \cdot x\sqrt{x} \cdot y\end{aligned}$$

Move on to simplify $\sqrt{y^2}$. The radicand only consists of a square term. So you can immediately simplify the expression. Squaring a term and finding the square root of a term are inverse operations. This means that $\sqrt{y^2}$ is y .

$$\begin{aligned}\sqrt{18x^3y^2} &= \sqrt{18} \cdot \sqrt{x^3} \cdot \sqrt{y^2} \\ &= 3\sqrt{2} \cdot x\sqrt{x} \cdot y\end{aligned}$$

In the expression, you can represent $\sqrt{y^2}$ as y . Now that you have simplified the square root factors, determine the product.

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Example 1 (continued)

EXAMPLE 1

Determine the simplest radical form of the given expression: $\sqrt{18x^3y^2}$

$$\begin{aligned}\sqrt{18x^3y^2} &= \sqrt{18} \cdot \sqrt{x^3} \cdot \sqrt{y^2} \\ &= 3\sqrt{2} \cdot x\sqrt{x} \cdot y && \text{Apply the Commutative} \\ & && \text{Property of Multiplication.} \\ &= 3 \cdot x \cdot y \cdot \sqrt{2} \cdot \sqrt{x} && \text{Multiply.} \\ &= 3xy \cdot \sqrt{2x} && \text{Simplify the expression.} \\ &= 3xy\sqrt{2x}\end{aligned}$$

Recall that the Commutative Property of Multiplication allows you to change the order of multiplication. Apply the property in this example by multiplying 3 , x , and y first. Then, multiply $\sqrt{2}$ and \sqrt{x} .

The product of 3 , x , and y can be represented as $3xy$. The product of $\sqrt{2}$ and \sqrt{x} can be represented as $\sqrt{2x}$.

Lastly, simplify the resulting expression. The simplest radical form of $\sqrt{18x^3y^2}$ is $3xy\sqrt{2x}$.

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Example 2

EXAMPLE 2

What is the simplest radical form of the given expression: $\sqrt{245a^5}$?

$$\sqrt{245a^5} = \sqrt{245} \cdot \sqrt{a^5}$$

What property justifies the work shown above?

Commutative Property of Multiplication Product Property of Radicals Product of Powers Property

What is the simplest radical form of the given expression: $\sqrt{245a^5}$?

$$\sqrt{245a^5} = \sqrt{245} \cdot \sqrt{a^5}$$

What property justifies the work shown above?

- A) Commutative Property of Multiplication
- B) Product Property of Radicals
- C) Product of Powers Property

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Topic 1 Content: Simplifying Square Roots of Algebraic Expressions

Example 2 (continued)

EXAMPLE 2

What is the simplest radical form of the given expression: $\sqrt{245a^5}$?

$$\sqrt{245a^5} = \sqrt{245} \cdot \sqrt{a^5}$$

The Product Property of Radicals states that the square root of a product is equal to the product of the square roots of the factors.

Product Property of Radicals

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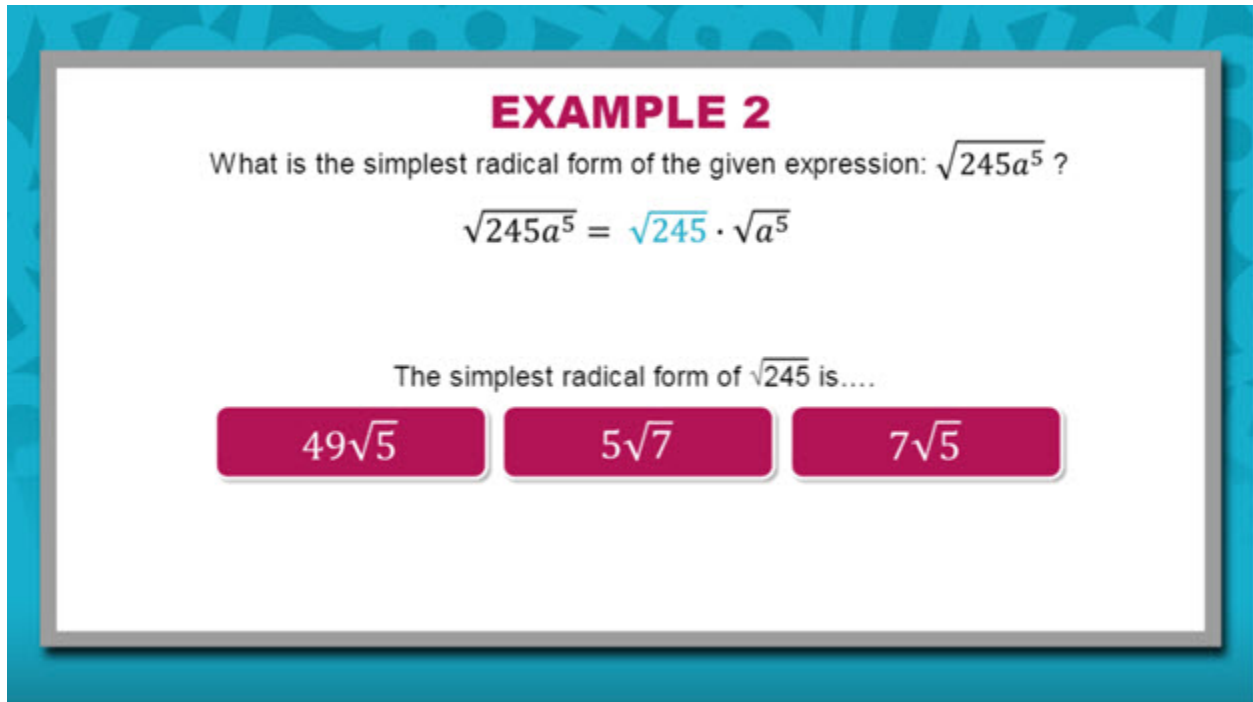
The Product Property of Radicals states that the square root of a product is equal to the product of the square roots of the factors.

$$\sqrt{245a^5} = \sqrt{245} \cdot \sqrt{a^5}$$

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Example 2 (continued)



EXAMPLE 2

What is the simplest radical form of the given expression: $\sqrt{245a^5}$?

$$\sqrt{245a^5} = \sqrt{245} \cdot \sqrt{a^5}$$

The simplest radical form of $\sqrt{245}$ is....

$49\sqrt{5}$ $5\sqrt{7}$ $7\sqrt{5}$

The next step is to simplify each square root factor. Begin with $\sqrt{245}$.

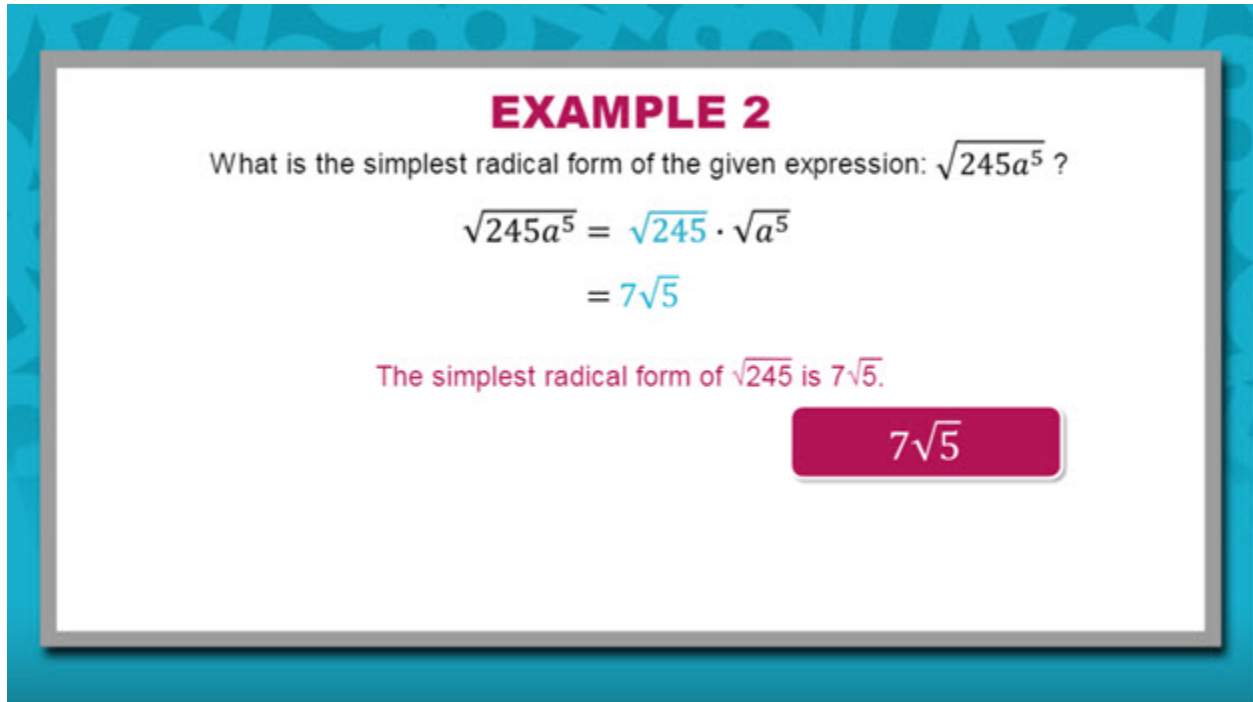
The simplest radical form of $\sqrt{245}$ is ...

- A) $49\sqrt{5}$
- B) $5\sqrt{7}$
- C) $7\sqrt{5}$

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Topic 1 Content: Simplifying Square Roots of Algebraic Expressions

Example 2 (continued)



EXAMPLE 2

What is the simplest radical form of the given expression: $\sqrt{245a^5}$?

$$\begin{aligned}\sqrt{245a^5} &= \sqrt{245} \cdot \sqrt{a^5} \\ &= 7\sqrt{5}\end{aligned}$$

The simplest radical form of $\sqrt{245}$ is $7\sqrt{5}$.

$7\sqrt{5}$

$$\begin{aligned}\sqrt{245a^5} &= \sqrt{245} \cdot \sqrt{a^5} \\ &= 7\sqrt{5}\end{aligned}$$

The simplest radical form of $\sqrt{245}$ is $7\sqrt{5}$.

In the expression, you can now represent $\sqrt{245}$ as $7\sqrt{5}$.

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Example 2 (continued)

EXAMPLE 2

What is the simplest radical form of the given expression: $\sqrt{245a^5}$?

$\sqrt{245} = \sqrt{5 \cdot 7 \cdot 7}$	Complete the prime factorization of 245.
$= \sqrt{5 \cdot 7^2}$	Represent multiple factors as a square term.
$= \sqrt{5} \cdot \sqrt{7^2}$	Apply the Product Property of Radicals.
$= \sqrt{5} \cdot 7$	Simplify the perfect square.
$= 7\sqrt{5}$	Simplify the expression.

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$\sqrt{245} = \sqrt{5 \cdot 7 \cdot 7}$	Complete the prime factorization of 245.
$= \sqrt{5 \cdot 7^2}$	Represent multiple factors as a square term.
$= \sqrt{5} \cdot \sqrt{7^2}$	Apply the Product Property of Radicals.
$= \sqrt{5} \cdot 7$	Simplify the perfect square.
$= 7\sqrt{5}$	Simplify the expression.

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Example 2 (continued)

EXAMPLE 2

What is the simplest radical form of the given expression: $\sqrt{245a^5}$?

$$\begin{aligned}\sqrt{245a^5} &= \sqrt{245} \cdot \sqrt{a^5} \\ &= 7\sqrt{5}\end{aligned}$$

What is the simplest radical form of $\sqrt{a^5}$?

$a\sqrt{a^4}$ a $a^2\sqrt{a}$

Move on to simplify $\sqrt{a^5}$.

What is the simplest radical form of $\sqrt{a^5}$?

- A) $a\sqrt{a^4}$
- B) a
- C) $a^2\sqrt{a}$

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Example 2 (continued)

EXAMPLE 2

What is the simplest radical form of the given expression: $\sqrt{245a^5}$?

$$\begin{aligned}\sqrt{245a^5} &= \sqrt{245} \cdot \sqrt{a^5} \\ &= 7\sqrt{5} \cdot a^2\sqrt{a}\end{aligned}$$

The simplest radical form of $\sqrt{a^5}$ is $a^2\sqrt{a}$.

$a^2\sqrt{a}$

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$$\begin{aligned}\sqrt{245a^5} &= \sqrt{245} \cdot \sqrt{a^5} \\ &= 7\sqrt{5} \cdot a^2\sqrt{a}\end{aligned}$$

The simplest radical form of $\sqrt{a^5}$ is $a^2\sqrt{a}$.

In the expression, you can now represent $\sqrt{a^5}$ as $a^2\sqrt{a}$.

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Example 2 (continued)

EXAMPLE 2

What is the simplest radical form of the given expression: $\sqrt{245a^5}$?

$\sqrt{a^5} = \sqrt{a \cdot a \cdot a \cdot a \cdot a}$	Complete the prime factorization of a^5 .
$= \sqrt{a^2 \cdot a^2 \cdot a}$	Represent multiple factors as a square term.
$= \sqrt{a^2} \cdot \sqrt{a^2} \cdot \sqrt{a}$	Apply the Product Property of Radicals.
$= a \cdot a \cdot \sqrt{a}$	Simplify the perfect squares.
$= a^2\sqrt{a}$	Simplify the expression.

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$\sqrt{a^5} = \sqrt{a \cdot a \cdot a \cdot a \cdot a}$	Complete the prime factorization of a^5 .
$= \sqrt{a^2 \cdot a^2 \cdot a}$	Represent multiple factors as square terms.
$= \sqrt{a^2} \cdot \sqrt{a^2} \cdot \sqrt{a}$	Apply the Product Property of Radicals.
$= a \cdot a \cdot \sqrt{a}$	Simplify the perfect squares.
$= a^2\sqrt{a}$	Simplify the expression.

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Example 2 (continued)

EXAMPLE 2

What is the simplest radical form of the given expression: $\sqrt{245a^5}$?

$$\begin{aligned}\sqrt{245a^5} &= \sqrt{245} \cdot \sqrt{a^5} && \text{Step 1} \\ &= 7\sqrt{5} \cdot a^2\sqrt{a} && \text{Step 2} \\ &= 7 \cdot a^2 \cdot \sqrt{5} \cdot \sqrt{a} && \text{Step 3}\end{aligned}$$

What property justifies the works shown between Steps 2 and 3?

Product of Powers Property Commutative Property of Multiplication Product Property of Radicals

Now that you have simplified the square root factors, determine the product.

$$\begin{aligned}\sqrt{245a^5} &= \sqrt{245} \cdot \sqrt{a^5} && \text{Step 1} \\ &= 7\sqrt{5} \cdot a^2\sqrt{a} && \text{Step 2} \\ &= 7 \cdot a^2 \cdot \sqrt{5} \cdot \sqrt{a} && \text{Step 3}\end{aligned}$$

What property justifies the work shown between Steps 2 and 3?

- A) Product of Powers Property
- B) Commutative Property of Multiplication
- C) Product Property of Radicals

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Example 2 (continued)

EXAMPLE 2

What is the simplest radical form of the given expression: $\sqrt{245a^5}$?

$$\begin{aligned}\sqrt{245a^5} &= \sqrt{245} \cdot \sqrt{a^5} && \text{Step 1} \\ &= 7\sqrt{5} \cdot a^2\sqrt{a} && \text{Step 2} \\ &= 7 \cdot a^2 \cdot \sqrt{5} \cdot \sqrt{a} && \text{Step 3}\end{aligned}$$

The Commutative Property of Multiplication allows you to change the order of multiplication, as shown in the work between Steps 2 and 3.

Commutative Property of Multiplication

Next

The Commutative Property of Multiplication allows you to change the order of multiplication, as shown in the work between Steps 2 and 3.

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Example 2 (continued)

EXAMPLE 2

What is the simplest radical form of the given expression: $\sqrt{245a^5}$?

$$\begin{aligned}\sqrt{245a^5} &= \sqrt{245} \cdot \sqrt{a^5} \\ &= 7\sqrt{5} \cdot a^2\sqrt{a} \\ &= 7 \cdot a^2 \cdot \sqrt{5} \cdot \sqrt{a}\end{aligned}$$

The simplest radical form of the given expression is...

$7a^2\sqrt{5a}$ $5a\sqrt{7a^2}$ $35a^3$

What is the simplest radical form of the given expression: $\sqrt{245a^5}$?

$$\begin{aligned}\sqrt{245a^5} &= \sqrt{245} \cdot \sqrt{a^5} \\ &= 7\sqrt{5} \cdot a^2\sqrt{a} \\ &= 7 \cdot a^2 \cdot \sqrt{5} \cdot \sqrt{a} \\ &= ?\end{aligned}$$

- A) $7a^2\sqrt{5a}$
- B) $5a\sqrt{7a^2}$
- C) $35a^3$

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Example 2 (continued)

EXAMPLE 2

What is the simplest radical form of the given expression: $\sqrt{245a^5}$?

$$\begin{aligned}\sqrt{245a^5} &= \sqrt{245} \cdot \sqrt{a^5} \\ &= 7\sqrt{5} \cdot a^2\sqrt{a} \\ &= 7 \cdot a^2 \cdot \sqrt{5} \cdot \sqrt{a} \\ &= 7a^2\sqrt{5a}\end{aligned}$$

The simplest radical form of the given expression is $7a^2\sqrt{5a}$.

$7a^2\sqrt{5a}$ [View Work](#) [Menu](#)

The simplest radical form of the given expression is $7a^2\sqrt{5a}$.

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Example 2 (continued)

EXAMPLE 2

What is the simplest radical form of the given expression: $\sqrt{245a^5}$?

$\sqrt{245a^5} = \sqrt{245} \cdot \sqrt{a^5}$	Apply the Product Property of Radicals.
$= 7\sqrt{5} \cdot a^2\sqrt{a}$	Simplify the square root factors.
$= 7 \cdot a^2 \cdot \sqrt{5} \cdot \sqrt{a}$	Apply the Commutative Property of Multiplication.
$= 7a^2\sqrt{5a}$	Simplify the product.

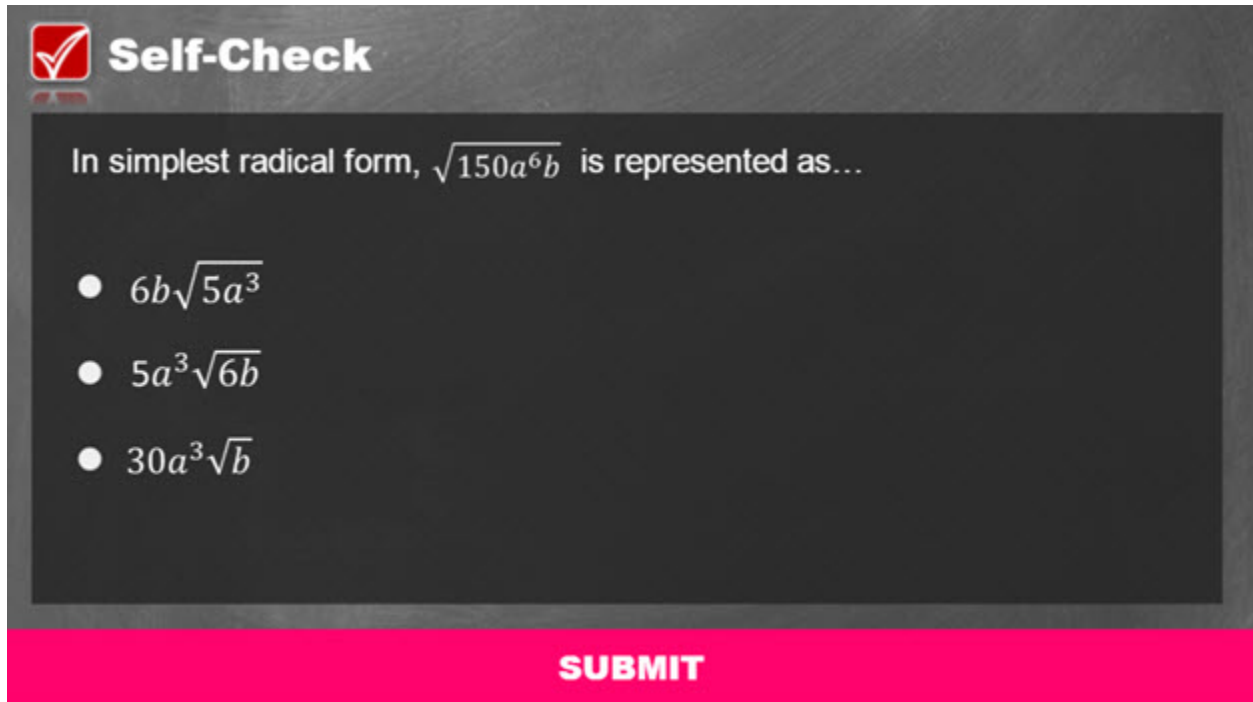
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$$\begin{aligned}\sqrt{245a^5} &= \sqrt{245} \cdot \sqrt{a^5} && \text{Apply the Product Property of Radicals.} \\ &= 7\sqrt{5} \cdot a^2\sqrt{a} && \text{Simplify the square root factors.} \\ &= 7 \cdot a^2 \cdot \sqrt{5} \cdot \sqrt{a} && \text{Apply the Commutative Property of Multiplication.} \\ &= 7a^2\sqrt{5a} && \text{Simplify the product.}\end{aligned}$$

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Self-Check



Self-Check

In simplest radical form, $\sqrt{150a^6b}$ is represented as...

- $6b\sqrt{5a^3}$
- $5a^3\sqrt{6b}$
- $30a^3\sqrt{b}$

SUBMIT

Solve the problem in the image above to check your understanding of the content.

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Self-Check: Answer

Correct

That's correct! Follow the steps below to simplify.

Apply the Product Property of Radicals. $\sqrt{150a^6b} = \sqrt{150} \cdot \sqrt{a^6} \cdot \sqrt{b}$

Simplify the square root factors. $= 5\sqrt{6} \cdot a^3 \cdot \sqrt{b}$

Apply the Commutative Property of Multiplication. $= 5 \cdot a^3 \cdot \sqrt{6} \cdot \sqrt{b}$

Simplify the product. $= 5a^3\sqrt{6b}$

Continue

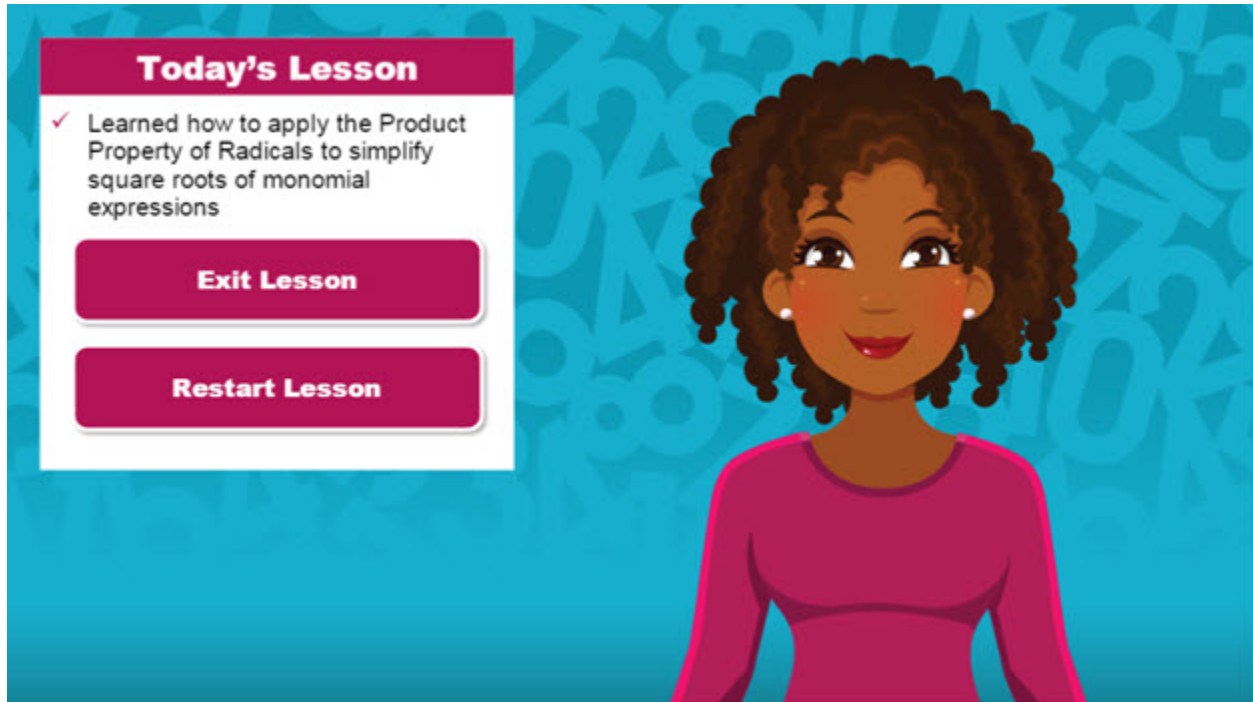
SUBMIT

For your reference, the image above shows the correct solution to the self-check problem.

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Conclusion



You have reached the conclusion of this lesson where you learned how to apply the Product Property of Radicals to simplify square roots of monomial expressions.