

# SIMPLIFY EXPRESSIONS WITH ROOTS

We will simplify expressions with roots.

What are we going to learn?

## Activate Prior Knowledge

A variable raised to an even exponent is a **perfect square**.

A variable raised to a multiple of 3 exponent is a **perfect cube**.

Find the square root.

$$1. \quad \sqrt{x^6} = x^3$$

$$2. \quad \sqrt{y^4} = y^2$$

Find the cube root.

$$3. \quad \sqrt[3]{x^9} = x^3$$

$$4. \quad \sqrt[3]{y^{15}} = y^5$$

## Make Connection

Students, you already know how to find the square roots and cube roots of variables. Now, we will simplify expressions with roots.



To simplify expressions with roots, use the root product rule.

## Root Product Rule

$$\sqrt[n]{a \cdot b} = \sqrt[n]{a} \cdot \sqrt[n]{b} \quad \text{Example: } \sqrt{40} = \sqrt{4 \cdot 10} = \sqrt{4} \cdot \sqrt{10} = 2\sqrt{10}$$

### CFU 1

Which shows how to rewrite  $\sqrt{50}$  using the root product rule?  
How do you know?  
A  $\sqrt{25} + \sqrt{25}$  B  $\sqrt{25} \cdot \sqrt{2}$   
Which of the following is a perfect square factor of 80?  
How do you know?  
A 64 B 16 C 8

### CFU 2

Which shows how to rewrite using the root product rule  $\sqrt[3]{54}$ ?  
How do you know?  
A  $\sqrt[3]{27} \cdot \sqrt{2}$  B  $\sqrt[3]{27} \cdot \sqrt{2}$   
Which of the following is a perfect cube factor of 80?  
How do you know?  
A 64 B 16 C 8

## Simplify

### Square Root

A square root ( $\sqrt{\quad}$ ) is the number that is multiplied by itself to form a product.

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

$$\sqrt{24x^4}$$

To simplify a square root, look for perfect square factors.

$$\sqrt{24x^4} = \sqrt{4 \cdot 6 \cdot x^4} = \sqrt{4} \cdot \sqrt{x^4} \cdot \sqrt{6} = 2x^2\sqrt{6}$$

- A square root is simplified when there are no more perfect square factors.  [Go to Skill Dev, #1](#)

### Cube Root


A cube root ( $\sqrt[3]{\quad}$ ) is the number that is multiplied by itself three times to form a product.

- A cube root is the inverse operation of cubing a number.

$$\sqrt[3]{24x^4}$$

To simplify a cube root, look for perfect cube factors.

$$\sqrt[3]{24x^4} = \sqrt[3]{8 \cdot 3 \cdot x^3 \cdot x} = \sqrt[3]{8} \cdot \sqrt[3]{x^3} \cdot \sqrt[3]{3} \cdot \sqrt[3]{x} = 2x\sqrt[3]{3x}$$

- A cube root is simplified when there are no more perfect cube factors.  [Go to Skill Dev, #2](#)

	Perfect Squares	Perfect Cubes
1	1	1
2	4	8
3	9	27
4	16	64
5	25	125
6	36	216
7	49	343
8	64	512
9	81	729
10	100	1000

To simplify expressions with roots, use the root product rule.

### Square Root

A square root ( $\sqrt{\quad}$ ) is the number that is multiplied by itself to form a product.

To simplify a square root, look for perfect square factors.

• A square root is simplified when there are no more perfect square factors.

### Simplify expressions with roots.

1 Identify<sub>1</sub> the largest perfect square factor. (circle) Hint: Refer to the chart.

a Factor the expression to isolate<sub>2</sub> perfect squares.

2 Rewrite the square root using the root product rule.

3 Simplify square roots that are perfect squares.

4 Check that the square root is simplified.

Hint: Make sure there are no more perfect square factors.

#### Root Product Rule

$$\sqrt[n]{a \cdot b} = \sqrt[n]{a} \cdot \sqrt[n]{b}$$

#### CFU

- How did I/you factor the expression to isolate perfect squares?
- How did I/you rewrite the square root using the root product rule?
- How did I/you simplify square roots that are perfect squares?
- How did I/you check that the square root is simplified?

	Perfect Squares	Perfect Cubes
1	1	1
2	4	8
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8	64	512
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10	100	1000

1.  $\sqrt{20w^5}$

$$\sqrt{4w^4 \cdot 5w} = \sqrt{4w^4} \cdot \sqrt{5w}$$

$$2w^2\sqrt{5w}$$

2.  $\sqrt{27e^3}$

$$\sqrt{9e^2 \cdot 3e} = \sqrt{9e^2} \cdot \sqrt{3e}$$

$$3e\sqrt{3e}$$

3.  $\sqrt{36q^7}$

$$\sqrt{36q^6 \cdot q} = \sqrt{36q^6} \cdot \sqrt{q}$$

$$6q^3\sqrt{q}$$

4.  $\sqrt{45p^4}$

$$\sqrt{9p^4 \cdot 5} = \sqrt{9p^4} \cdot \sqrt{5}$$

$$3p^2\sqrt{5}$$



Back to  
Concept Dev

#### Vocabulary

<sup>1</sup> find    <sup>2</sup> separate



## Skill Development/Guided Practice 2

To simplify expressions with roots, use the root product rule.

### Cube Root

A cube root ( $\sqrt[3]{\quad}$ ) is the number that is multiplied by itself **three times** to form a product.

To simplify a cube root, look for **perfect cube factors**.

- A cube root is *simplified* when there are no more *perfect cube factors*.

### Simplify expressions with roots.

1 Identify the largest perfect square factor. (circle) Hint: Refer to the chart.

a Factor the expression to isolate perfect squares.

2 Rewrite the square root using the root product rule.

3 Simplify square roots that are perfect squares.

4 Check that the square root is simplified.

Hint: Make sure there are no more perfect square factors

### Root Product Rule

$$\sqrt[n]{a \cdot b} = \sqrt[n]{a} \cdot \sqrt[n]{b}$$

### CFU

- 1a How did I/you factor the expression to isolate perfect squares?
- 2 How did I/you rewrite the square root using the root product rule?
- 3 How did I/you simplify square roots that are perfect squares?
- 4 How did I/you check that the square root is simplified?

1.  $\sqrt[3]{-54r^7}$

$$\sqrt[3]{-27r^6 \cdot 2r} = \sqrt[3]{-27r^6} \cdot \sqrt[3]{2r}$$

$$\boxed{-3r^2\sqrt[3]{2r}}$$

2.  $\sqrt[3]{24t^5}$

$$\sqrt[3]{8t^3 \cdot 3t^2} = \sqrt[3]{8t^3} \cdot \sqrt[3]{3t^2}$$

$$\boxed{2t\sqrt[3]{3t^2}}$$

3.  $\sqrt[3]{56h^9}$

$$\sqrt[3]{8h^9 \cdot 7} = \sqrt[3]{8h^9} \cdot \sqrt[3]{7}$$

$$\boxed{2h^3\sqrt[3]{7}}$$

4.  $\sqrt[3]{-64g^4}$

$$\sqrt[3]{-64g^3 \cdot g} = \sqrt[3]{-64g^3} \cdot \sqrt[3]{g}$$

$$\boxed{-4g\sqrt[3]{g}}$$

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To simplify expressions with roots, use the root product rule.

- 1 *Simplifying expressions with roots will help you solve more difficult math problems.*

Quadratic Equation:  $3x^2 + 5x - 2 = 0$

Solution:  $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$        $x = \frac{-5 \pm \sqrt{5^2 - 4(3)(2)}}{2(3)}$

- 2 *Simplifying expressions with roots will help you do well on tests.*

Sample Test Question:

3.  $\sqrt{16} + \sqrt[3]{8} =$

- A 4
- B 6
- C 9
- D 10

#### CFU

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



To simplify expressions with roots, use the root product rule.

**Root Product Rule**  
 $\sqrt[n]{a \cdot b} = \sqrt[n]{a} \cdot \sqrt[n]{b}$

<b>Square Root</b>	<p>To <u>simplify a square root</u>, look for <u>perfect square</u> factors.</p> <ul style="list-style-type: none"> <li>A <u>square root</u> is <u>simplified</u> when there are no more <u>perfect square</u> factors.</li> </ul>
<b>Cube Root</b>	<p>To <u>simplify a cube root</u>, look for <u>perfect cube</u> factors.</p> <ul style="list-style-type: none"> <li>A <u>cube root</u> is <u>simplified</u> when there are no more <u>perfect cube</u> factors.</li> </ul>

**Skill Closure**

Simplify expressions with roots.

- 1 Identify the largest perfect square factor. (circle) Hint: Refer to the chart.
  - a Factor the expression to isolate perfect squares.
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- 4 Check that the square root is simplified. Hint: Make sure there are no more perfect square factors

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1.  $\sqrt{50b^3}$   
 $\sqrt{25b^2 \cdot 2b} = \sqrt{25b^2} \cdot \sqrt{2b}$   
 $5b\sqrt{2b}$

2.  $\sqrt[3]{40k^7}$   
 $\sqrt[3]{8k^6 \cdot 5k} = \sqrt[3]{8k^6} \cdot \sqrt[3]{5k}$   
 $2k^2\sqrt[3]{5k}$

**Constructed Response Closure**

Explain why the expression  $2d^3\sqrt{32d^3}$  is NOT simplified.

**Summary Closure**

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

## Independent Practice

To **simplify expressions with roots**, use the root product rule.

### Square Root

A **square root** ( $\sqrt{\quad}$ ) is the number that is multiplied by itself to form a product.

To **simplify a square root**, look for **perfect square** factors.

- A **square root is simplified** when there are no more **perfect square factors**.

### Cube Root

A **cube root** ( $\sqrt[3]{\quad}$ ) is the number that is multiplied by itself **three times** to form a product.

To **simplify a cube root**, look for **perfect cube** factors.

- A **cube root is simplified** when there are no more **perfect cube factors**.

### Root Product Rule

$$\sqrt[n]{a \cdot b} = \sqrt[n]{a} \cdot \sqrt[n]{b}$$

### Simplify expressions with roots.

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$$1. \sqrt{75j^7}$$

$$\sqrt{25j^6 \cdot 3j} = \sqrt{25j^6} \cdot \sqrt{3j}$$

$$5j^3\sqrt{3j}$$

$$2. \sqrt{49f^3}$$

$$\sqrt{49f^2 \cdot f} = \sqrt{49f^2} \cdot \sqrt{f}$$

$$7f\sqrt{f}$$

$$3. \sqrt[3]{48p^5}$$

$$\sqrt[3]{8p^3 \cdot 6p^2} = \sqrt[3]{8p^3} \cdot \sqrt[3]{6p^2}$$

$$2p\sqrt[3]{6p^2}$$

$$4. \sqrt[3]{-81g^9}$$

$$\sqrt[3]{-27g^9 \cdot 3} = \sqrt[3]{-27g^9} \cdot \sqrt[3]{3}$$

$$-3g^3\sqrt[3]{3}$$

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$$\sqrt[n]{a \cdot b} = \sqrt[n]{a} \cdot \sqrt[n]{b}$$

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1.  $\sqrt{125d^6}$

$$\sqrt{25d^6 \cdot 5} = \sqrt{25d^6} \cdot \sqrt{5}$$

$$5d^3\sqrt{5}$$

2.  $\sqrt{98y^{11}}$

$$\sqrt{49y^{10} \cdot 2y} = \sqrt{49y^{10}} \cdot \sqrt{2y}$$

$$7y^5\sqrt{2y}$$

3.  $\sqrt[3]{125d^6}$

$$\sqrt[3]{125d^6}$$

$$5d^2$$

4.  $\sqrt[3]{-128p^2}$

$$\sqrt[3]{-64 \cdot 2p^2} = \sqrt[3]{-64} \cdot \sqrt[3]{2p^2}$$

$$-4\sqrt[3]{2p^2}$$

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1.  $\sqrt{6n^9}$   
 $\sqrt{n^8 \cdot 6n} = \sqrt{n^8} \cdot \sqrt{6n}$   
 $n^4 \sqrt{6n}$

2.  $\sqrt{300x}$   
 $\sqrt{100 \cdot 3x} = \sqrt{100} \cdot \sqrt{3x}$   
 $10\sqrt{3x}$

3.  $\sqrt[3]{125p^5b^4}$   
 $\sqrt[3]{125p^3b^3 \cdot p^2b} = \sqrt[3]{125p^3b^3} \cdot \sqrt[3]{p^2b}$   
 $5pb^2\sqrt[3]{p^2b}$

4.  $\sqrt[3]{80w^6}$   
 $\sqrt[3]{8w^6 \cdot 10} = \sqrt[3]{8w^6} \cdot \sqrt[3]{10}$   
 $2w^2\sqrt[3]{10}$

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9	81	729
10	100	1000

1.  $\sqrt{5j^7}$   
 $\sqrt{j^6 \cdot 5j} = \sqrt{j^6} \cdot \sqrt{5j}$   
 $j^3 \sqrt{5j}$

2.  $\sqrt{k^7 f^3}$   
 $\sqrt{k^6 f^2 \cdot kf} = \sqrt{k^6 f^2} \cdot \sqrt{kf}$   
 $k^3 f \sqrt{kf}$

3.  $\sqrt[3]{18p^2}$   
 Cannot be simplified.

4.  $\sqrt[3]{-27g^9 h^{12}}$   
 $\sqrt[3]{-27g^9 h^{12}}$   
 $-3g^3 h^4$



# EDI – Cognitive, Teaching, and English Learner Strategies

Learning Objective: We will simplify expressions with roots.

## Cognitive Strategies

## Teaching Strategies

Elaboration		Demonstration	
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## Language Strategies

Targeted Vocabulary	Academic	identify, isolate
	Content	perfect square, perfect cube, square root, cube root
	Support	
Vocabulary Strategy	Multiple-Meaning	
	Synonym	identify, isolate
	Definition	perfect square, perfect cube, square root, cube root
	Homophone	
	Internal Context Clue	
Listen, Speak	Similar Sounds	
Read	Tracked Reading	
Write	Writing	

## Content Access Strategies

Comprehensible Input	Cognates	
Contextual Clues	Graphic Organizer	
	Contextualized Definitions	
	Pictures	