Simplify.

1. $\sqrt{16} = 4$
   4 4

2. $\sqrt{64} = 8$
   8 8

3. $\sqrt{225} = 15$
   15 15

4. $\sqrt{2025} = 45$
   45 45

5. $\sqrt{57,600} = 240$
   240 240

6. $\sqrt{36} = 6$
   6 6

7. $\sqrt{400}$
   20 20

8. $\sqrt{4}$
   2 2

9. $\sqrt{3600} = 60$
   60 60

Square root: need to find two factors that are the same number → that when multiplied together equal the number under the radical.

Warm Up

Determine whether the function represents *exponential growth* or *exponential decay*. Identify the percent rate of change.

1. $y = 5(0.7)^t$
growth

2. $y = 49(1.04)^t$
growth

3. $r(t) = 0.5(0.95)^t$
decay

4. $g(t) = 3\left(\frac{4}{5}\right)^t$ decay

Cumulative Warm Up

Essential Question

How can you multiply and divide square roots?

- are they the same as working with variables.

What you will learn:

- Use properties of radicals to simplify expressions
- Simplify expressions by rationalizing the denominator
- Perform operations with radicals

Essential Question

Core Concept

Product Property of Square Roots

Words The square root of a product equals the product of the square roots of the factors.

Numbers $\sqrt{9 \cdot 5} = \sqrt{9} \cdot \sqrt{5} = 3\sqrt{5}$

Algebra $\sqrt{ab} = \sqrt{a} \cdot \sqrt{b}$, where $a, b \geq 0$

Radical Expression: an expression that contains a radical

Simplest Form:

- No radicands have perfect n^{th} powers a factors other than 1.
- No radicand contains a fraction
- No radicals appear in the denominator of a fraction

Core Concept

a. $\sqrt{108} = \sqrt{36 \cdot 3}$ Factor using the greatest perfect square factor.

$= \sqrt{36} \cdot \sqrt{3}$ Product Property of Square Roots

$= 6\sqrt{3}$ Simplify.

b. $\sqrt{9x^3} = \sqrt{9 \cdot x^2 \cdot x}$ Factor using the greatest perfect square factor.

$= \sqrt{9} \cdot \sqrt{x^2} \cdot \sqrt{x}$ Product Property of Square Roots

$= 3x\sqrt{x}$ Simplify.

- Use factor trees and factor to prime numbers
- always look for pairs when working w/ square root

Index $\sqrt{}$

Index tells us to look for pairs

- leave any value that does not have a pair under the radical

Example 1

Simplify the expression.

1. $\sqrt{24}$

$2\sqrt{2 \cdot 3}$

$\boxed{2\sqrt{6}}$

2. $-\sqrt{80}$

$-1 \cdot 2 \cdot 2\sqrt{5}$

$\boxed{-4\sqrt{5}}$

3. $\sqrt{49x^3}$

$7 \cdot x\sqrt{x}$

$\boxed{7x\sqrt{x}}$

4. $\sqrt{75n^5}$

$5 \cdot n \cdot n\sqrt{3 \cdot n}$

$\boxed{5n^2\sqrt{3n}}$

Monitoring Progress 1-4

Core Concept

Quotient Property of Square Roots

Words The square root of a quotient equals the quotient of the square roots of the numerator and denominator.

Numbers $\sqrt{\frac{3}{4}} = \frac{\sqrt{3}}{\sqrt{4}} = \frac{\sqrt{3}}{2}$ **Algebra** $\sqrt{\frac{a}{b}} = \frac{\sqrt{a}}{\sqrt{b}}$, where $a \geq 0$ and $b > 0$

- If one big radical - you can do the square of the numerator and the square of the denominator independently.

Core Concept 2

a. $\sqrt{\frac{15}{64}} = \frac{\sqrt{15}}{\sqrt{64}}$ Quotient Property of Square Roots

$= \frac{\sqrt{15}}{8}$ Simplify.

b. $\sqrt{\frac{81}{x^2}} = \frac{\sqrt{81}}{\sqrt{x^2}}$ Quotient Property of Square Roots

$= \frac{9}{x}$ Simplify.

Example 2

a. $\sqrt[3]{-128} = \sqrt[3]{-64 \bullet 2}$ Factor using the greatest perfect cube factor.

$= \sqrt[3]{-64} \bullet \sqrt[3]{2}$ Product Property of Cube Roots

$= -4\sqrt[3]{2}$ Simplify.

b. $\sqrt[3]{125x^7} = \sqrt[3]{125 \bullet x^6 \bullet x}$ Factor using the greatest perfect cube factors.

$= \sqrt[3]{125} \bullet \sqrt[3]{x^6} \bullet \sqrt[3]{x}$ Product Property of Cube Roots

$= 5x^2\sqrt[3]{x}$ Simplify.

c. $\sqrt[3]{\frac{y}{216}} = \frac{\sqrt[3]{y}}{\sqrt[3]{216}}$ Quotient Property of Cube Roots

$= \frac{\sqrt[3]{y}}{6}$ Simplify.

d. $\sqrt[3]{\frac{8x^4}{27y^3}} = \frac{\sqrt[3]{8x^4}}{\sqrt[3]{27y^3}}$ Quotient Property of Cube Roots

$= \frac{\sqrt[3]{8 \bullet x^3 \bullet x}}{\sqrt[3]{27 \bullet y^3}}$ Factor using the greatest perfect cube factors.

$= \frac{\sqrt[3]{8} \bullet \sqrt[3]{x^3} \bullet \sqrt[3]{x}}{\sqrt[3]{27} \bullet \sqrt[3]{y^3}}$ Product Property of Cube Roots

$= \frac{2x\sqrt[3]{x}}{3y}$ Simplify.

Example 3

* Index number tells us how many grouping we need!

Simplify the expression.

5. $\sqrt{\frac{23}{9}}$ $\frac{\sqrt{23}}{\sqrt{9}} = \boxed{\frac{\sqrt{23}}{3}}$

6. $-\sqrt{\frac{17}{100}}$ $-\frac{\sqrt{17}}{\sqrt{100}}$ $\boxed{-\frac{\sqrt{17}}{10}}$

7. $\sqrt{\frac{36}{z^2}} = \frac{\sqrt{36}}{\sqrt{z^2}}$ $\boxed{\frac{6}{z}}$

8. $\sqrt{\frac{4x^2}{64}}$ $\frac{\sqrt{4x^2}}{\sqrt{64}} = \frac{2x}{8} = \frac{1x}{4}$

9. $\sqrt[3]{54}$
6 9
2 3 3 3
Index = 3
$\boxed{3\sqrt[3]{2}}$

10. $\sqrt[3]{16x^4}$
4 4 x x x x
2 2 2 2
$\boxed{2x\sqrt[3]{2x}}$

11. $\sqrt[3]{\frac{a}{-27}}$ $\frac{\sqrt[3]{a}}{\sqrt[3]{-27}}$ $\boxed{\frac{\sqrt[3]{a}}{-3}}$

12. $\sqrt[3]{\frac{25c^7d^3}{64}}$ $\frac{\sqrt[3]{25c^7d^3}}{\sqrt[3]{64}}$

$\frac{5 \cdot 5 \cdot c \cdot c \cdot c \cdot c \cdot c \cdot c \cdot c \cdot d \cdot d \cdot d}{4 \cdot 4 \cdot 4}$

$\boxed{\frac{c^2d\sqrt[3]{25c}}{4}}$

Monitoring Progress 5-12

· Can not have a radical In the denomcnator

· remove a radical by rationalizing the denominator

a. $\dfrac{\sqrt{5}}{\sqrt{3n}} = \dfrac{\sqrt{5}}{\sqrt{3n}} \bullet \dfrac{\sqrt{3n}}{\sqrt{3n}}$ Multiply by $\dfrac{\sqrt{3n}}{\sqrt{3n}}$.

$= \dfrac{\sqrt{15n}}{\sqrt{9n^2}}$ Product Property of Square Roots

$= \dfrac{\sqrt{15n}}{\sqrt{9} \bullet \sqrt{n^2}}$ Product Property of Square Roots

$= \dfrac{\sqrt{15n}}{3n}$ Simplify.

b. $\dfrac{2}{\sqrt[3]{9}} = \dfrac{2}{\sqrt[3]{9}} \bullet \dfrac{\sqrt[3]{3}}{\sqrt[3]{3}}$ Multiply by $\dfrac{\sqrt[3]{3}}{\sqrt[3]{3}}$.

$= \dfrac{2\sqrt[3]{3}}{\sqrt[3]{27}}$ Product Property of Cube Roots

$= \dfrac{2\sqrt[3]{3}}{3}$ Simplify.

Example 4

	2	$-\sqrt{3}$
2	4	$-2\sqrt{3}$
$+\sqrt{3}$	$2\sqrt{3}$	$-\sqrt{9}$ -3

$4-3=1$

Simplify $\dfrac{7}{2-\sqrt{3}} \cdot \dfrac{(2+\sqrt{3})}{(2+\sqrt{3})}$

$\dfrac{(7 \cdot 2 + 7 \cdot \sqrt{3})}{1} = \boxed{14 + 7\sqrt{3}}$

Example 5

32

2 14

2 8

2 4

2 2

Simplify the expression.

13. $\frac{1}{\sqrt{5}} \frac{(\sqrt{5})}{(\sqrt{5})}$ 14. $\frac{\sqrt{10}}{\sqrt{3}} \frac{(\sqrt{3})}{(\sqrt{3})}$ 15. $\frac{7}{\sqrt{2x}} \frac{(\sqrt{2x})}{(\sqrt{2x})}$ 16. $\sqrt{\frac{2y^2}{3}}$ $\frac{\sqrt{2y^2}}{\sqrt{3}} \frac{(\sqrt{3})}{(\sqrt{3})}$ $\boxed{\frac{y\sqrt{6}}{3}}$

$\boxed{\frac{\sqrt{5}}{5}}$ $\frac{\sqrt{30}}{3}$ $\frac{7\sqrt{2x}}{2x}$

17. $\frac{5}{\sqrt[3]{32}}$ 18. $\frac{8}{1+\sqrt{3}}$ 19. $\frac{\sqrt{13}}{\sqrt{5}-2}$ 20. $\frac{12}{\sqrt{2}+\sqrt{7}}$

$\frac{5}{2\sqrt[3]{4}} \frac{(\sqrt[3]{2})}{(\sqrt[3]{2})}$ $\frac{\overset{4}{8}}{1+\sqrt{3}} \frac{(1-\sqrt{3})}{(1-\sqrt{3})}$

$\boxed{\frac{5\sqrt[3]{2}}{4}}$ $\frac{-4+4\sqrt{3}}{+\cancel{2}}$

$\boxed{-4+4\sqrt{3}}$

Monitoring Progress 13-20

The distance d (in miles) that you can see to the horizon with your eye level h feet above the water is given by $d = \sqrt{\frac{3h}{2}}$. How far can you see when your eye level is 5 feet above the water?

Example 6

The ratio of the length to the width of a *golden rectangle* is $(1+\sqrt{5}) : 2$. The dimensions of the face of the Parthenon in Greece form a golden rectangle. What is the height h of the Parthenon?

Example 7

21. WHAT IF? In Example 6, how far can you see when your eye level is 35 feet above the water?

22. The dimensions of a dance floor form a golden rectangle. The shorter side of the dance floor is 50 feet. What is the length of the longer side of the dance floor?

Monitoring Progress 21-22

- Like terms
  - If values under the radical are the same you can add or subtract the coefficients

a. $5\sqrt{7}+\sqrt{11}-8\sqrt{7}=5\sqrt{7}-8\sqrt{7}+\sqrt{11}$ Commutative Property of Addition

$=(5-8)\sqrt{7}+\sqrt{11}$ Distributive Property

$=-3\sqrt{7}+\sqrt{11}$ Subtract.

b. $10\sqrt{5}+\sqrt{20}=10\sqrt{5}+\sqrt{4\bullet 5}$ Factor using the greatest perfect square factor.

$=10\sqrt{5}+\sqrt{4}\bullet\sqrt{5}$ Product Property of Square Roots

$=10\sqrt{5}+2\sqrt{5}$ Simplify.

$=(10+2)\sqrt{5}$ Distributive Property

$=12\sqrt{5}$ Add.

c. $6\sqrt[3]{x}+2\sqrt[3]{x}=(6+2)\sqrt[3]{x}$ Distributive Property

$=8\sqrt[3]{x}$ Add.

Example 8

distributive property

Simplify $\sqrt{5}\left(\sqrt{3}-\sqrt{75}\right)$.

$(\sqrt{5}\cdot\sqrt{3})+(\sqrt{5}\cdot-\sqrt{75})$ $\begin{matrix}5\\15\end{matrix}$

$\sqrt{15}+-5\sqrt{15}$

$-4\sqrt{15}$

Example 9

Simplify the expression.

23. $3\sqrt{2}-\sqrt{6}+10\sqrt{2}$

$13\sqrt{2}-\sqrt{6}$

24. $4\sqrt{7}-6\sqrt{63}$ $\begin{smallmatrix}9\\7\end{smallmatrix}$

$4\sqrt{7}-18\sqrt{7}$

$-14\sqrt{7}$

25. $4\sqrt[3]{5x}-11\sqrt[3]{5x}$

$-7\sqrt[3]{5x}$

26. $\sqrt{3}\left(8\sqrt{2}+7\sqrt{32}\right)$

$8\sqrt{6}+7\sqrt{96}$ $\begin{smallmatrix}6\\16\end{smallmatrix}$

$8\sqrt{6}+7\cdot4\sqrt{6}$

$8+28\sqrt{6}$

$36\sqrt{6}$

27. $\left(2\sqrt{5}-4\right)^2$

$(2\sqrt{5}-4)(2\sqrt{5}-4)$

28. $\sqrt[3]{-4}\left(\sqrt[3]{2}-\sqrt[3]{16}\right)$

Monitoring Progress 23-28

Writing Prompt: This was a very long lesson. Right now I am feeling …

Closure