1-3 Square Roots

Starter 1.3

Round to the <u>nearest tenth.</u>

1. 3.14 **3.1** **2.** 1.97 **2.0**

Find each square root.

3. $\sqrt{16}$ **4** **4.** $\sqrt{625}$ **25**

Write each fraction in <u>simplest form</u>.

5. $\frac{24}{72}$ $\frac{1}{3}$ **6.** $\frac{169}{182}$ $\frac{13}{14}$

Simplify.

7. $\frac{1}{3} \cdot \frac{5}{3}$ $\frac{5}{9}$ **8.** $\frac{12}{18} \cdot \frac{6}{21}$ $\frac{4}{21}$

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Vocabulary

- **Radical symbol** $(\sqrt{\ })$
- **Radicand**— number or expression under the radical symbol
- **Principal root** — positive square root of a number
- **rationalize the denominator**
- **like radical terms**

$\sqrt{25} = 5$ $-\sqrt{25} = -5$ $\pm\sqrt{25} = \pm 5 = 5$ or -5

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Perfect Squares

Number	Square
1	1
2	4
3	9
4	16
5	25
6	36
7	49
8	64
9	81
10	100

Number	Square
11	121
12	144
13	169
14	196
15	225
16	256
17	289
18	324
19	361
20	400

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Example 1: Estimating Square Roots

Estimate $\sqrt{27}$ to the nearest tenth.

$\sqrt{25} < \sqrt{27} < \sqrt{36}$ *Find the two perfect squares that 27 lies between.*

$5 < \sqrt{27} < 6$ *Find the two integers that lies between $\sqrt{27}$.*

Because 27 is closer to 25 than to 36, $\sqrt{27}$ is close to 5 than to 6.

Try 5.2: $5.2^2 = 27.04$ *Too high, try 5.1.*

$5.1^2 = 26.01$ *Too low*

Because 27 is closer to 27.04 than 26.01, $\sqrt{27}$ is closer to 5.2 than to 5.1.

Check On a calculator $\sqrt{27} \approx 5.1961524 \approx 5.1$ rounded to the nearest tenth. ✓

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Check It Out! Example 1

Estimate $-\sqrt{55}$ to the nearest tenth.

$-\sqrt{49} < -\sqrt{55} < -\sqrt{64}$ *Find the two perfect squares that –55 lies between.*

$-7 < -\sqrt{55} < -8$ *Find the two integers that lies between $-\sqrt{55}$.*

Because –55 is closer to –49 than to –64, $-\sqrt{55}$ is closer to –7 than to –8.

Try 7.2: $7.2^2 = 51.84$ *Too low, try 7.4*

$7.4^2 = 54.76$ *Too low but very close*

Because 55 is closer to 54.76 than 51.84, $-\sqrt{55}$ is closer to 7.4 than to 7.2.

Check On a calculator $-\sqrt{55} \approx -7.4161984 \approx -7.4$ rounded to the nearest tenth. ✓

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Properties of Square Roots

For $a \geq 0$ and $b > 0$,

WORDS	NUMBERS	ALGEBRA
Product Property of Square Roots The square root of a product is equal to the product of the square roots of the factors.	$\sqrt{12} = \sqrt{4 \cdot 3} = \sqrt{4} \cdot \sqrt{3} = 2\sqrt{3}$ $\sqrt{8} \cdot \sqrt{2} = \sqrt{8 \cdot 2} = \sqrt{16} = 4$	$\sqrt{ab} = \sqrt{a} \cdot \sqrt{b}$ $\sqrt{a} \cdot \sqrt{b} = \sqrt{ab}$
Quotient Property of Square Roots The square root of a quotient is equal to the quotient of the square roots of the dividend and the divisor.	$\sqrt{\frac{25}{16}} = \frac{\sqrt{25}}{\sqrt{16}} = \frac{5}{4}$ $\frac{\sqrt{18}}{\sqrt{2}} = \sqrt{\frac{18}{2}} = \sqrt{9} = 3$	$\sqrt{\frac{a}{b}} = \frac{\sqrt{a}}{\sqrt{b}}$ $\frac{\sqrt{a}}{\sqrt{b}} = \sqrt{\frac{a}{b}}$

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Example 2: Simplifying Square–Root Expressions

Simplify each expression.

A. $\sqrt{32}$

$\sqrt{16 \cdot 2}$ *Find a perfect square factor of 32.*

$\sqrt{16} \cdot \sqrt{2}$ *Product Property of Square Roots*

$4\sqrt{2}$

B. $\sqrt{\frac{25}{36}}$

$\frac{\sqrt{25}}{\sqrt{36}}$ *Quotient Property of Square Roots*

$\frac{5}{6}$

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Example 2: Simplifying Square–Root Expressions

Simplify each expression.

C. $\sqrt{3} \cdot \sqrt{12}$

$\sqrt{3 \cdot 12}$ *Product Property of Square Roots*

$\sqrt{36} = 6$

D. $\frac{\sqrt{500}}{\sqrt{5}}$

$\sqrt{\frac{500}{5}}$ *Quotient Property of Square Roots*

$\sqrt{100} = 10$

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1-3 Square Roots

Check It Out! Example 2

Simplify each expression.

A. $\sqrt{48}$

$\sqrt{16 \cdot 3}$ *Find a perfect square factor of 48.*

$\sqrt{16} \cdot \sqrt{3}$ *Product Property of Square Roots*

$4\sqrt{3}$

B. $\sqrt{\frac{36}{16}}$

$\frac{\sqrt{36}}{\sqrt{16}}$ *Quotient Property of Square Roots*

$\frac{6}{4} = \frac{3}{2}$ *Simplify.*

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1-3 Square Roots

Check It Out! Example 2

Simplify each expression.

C. $\sqrt{5} \cdot \sqrt{20}$

$\sqrt{5 \cdot 20}$ *Product Property of Square Roots*

$\sqrt{100} = 10$

D. $\frac{\sqrt{147}}{\sqrt{3}}$

$\sqrt{\frac{147}{3}}$ *Quotient Property of Square Roots*

$\sqrt{49} = 7$

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If a fraction has a denominator that is a square root, you can simplify it by **rationalizing the denominator**. To do this, multiply both the numerator and denominator by a number that produces a perfect square under the radical sign in the denominator.

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Example 3: Rationalizing the Denominator

Simplify by rationalizing the denominator.

$\frac{3\sqrt{5}}{\sqrt{2}}$

$\frac{3\sqrt{5}}{\sqrt{2}} \cdot \frac{\sqrt{2}}{\sqrt{2}}$ *Multiply by a form of 1.*

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

$\frac{3\sqrt{10}}{2}$

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Example 3: Rationalizing the Denominator

Simplify the expression.

$\frac{\sqrt{2}}{\sqrt{8}}$

$\frac{\sqrt{2}}{\sqrt{8}} \cdot \frac{\sqrt{8}}{\sqrt{8}}$ *Multiply by a form of 1.*

$\frac{\sqrt{2 \cdot 8}}{8}$ $\sqrt{8} \cdot \sqrt{8} = 8$

$\frac{\sqrt{16}}{8} = \frac{4}{8} = \frac{1}{2}$ $\sqrt{16} = 4$

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Check It Out! Example 3a

Simplify by rationalizing the denominator.

$\frac{3\sqrt{5}}{\sqrt{7}}$

$\frac{3\sqrt{5}}{\sqrt{7}} \cdot \frac{\sqrt{7}}{\sqrt{7}}$ *Multiply by a form of 1.*

$\frac{3\sqrt{5 \cdot 7}}{7}$ $\sqrt{7} \cdot \sqrt{7} = 7$

$\frac{3\sqrt{35}}{7}$

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Check It Out! Example 3b

Simplify by rationalizing the denominator.

$\frac{5}{\sqrt{10}}$

$\frac{5}{\sqrt{10}} \cdot \frac{\sqrt{10}}{\sqrt{10}}$ *Multiply by a form of 1.*

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

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Square roots that have the same radicand are called **like radical terms**.

Like Radicals	$\sqrt{2}$ and $3\sqrt{2}$	$-6\sqrt{15}$ and $7\sqrt{15}$	$\sqrt{ab^2}$ and $4\sqrt{ab^2}$
Unlike Radicals	$2\sqrt{5}$ and $\sqrt{2}$	$\sqrt{x}$ and $\sqrt{3x}$	$\sqrt{xy^2}$ and $\sqrt{x^2y}$

To add or subtract square roots, first simplify each radical term and then combine like radical terms by adding or subtracting their coefficients.

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Example 4: Adding and Subtracting Square Roots

Add.

$9\sqrt{3}+7\sqrt{3}$

$(9+7)\sqrt{3}$

$16\sqrt{3}$

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1-3 Square Roots

Example 4: Adding and Subtracting Square Roots

Subtract.

$6\sqrt{5}-\sqrt{20}$

$6\sqrt{5}-\sqrt{4 \cdot 5}$ *Simplify radical terms.*

$6\sqrt{5}-2\sqrt{5}$

$(6-2)\sqrt{5}$ *Combine like radical terms.*

$4\sqrt{5}$

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Check It Out! Example 4a

Add or subtract.

$3\sqrt{5} + 10\sqrt{5}$

$(3+10)\sqrt{5}$ *Combine like radical terms.*

$13\sqrt{5}$

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1-3 Square Roots

Check It Out! Example 4b

Add or subtract.

$\sqrt{80} - 5\sqrt{5}$

$\sqrt{16 \cdot 5} - 5\sqrt{5}$ *Simplify radical terms.*

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

$(4-5)\sqrt{5}$ *Combine like radical terms.*

$-\sqrt{5}$

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