Name _____ Date _____

# 9.1 Properties of Radicals

**For use with Exploration 9.1**

**Essential Question** How can you multiply and divide square roots?

## 1 EXPLORATION: Operations with Square Roots

**Work with a partner.** For each operation with square roots, compare the results obtained using the two indicated orders of operations. What can you conclude?

**a. Square Roots and Addition**

Is $\sqrt{36} + \sqrt{64}$ equal to $\sqrt{36 + 64}$?

In general, is $\sqrt{a} + \sqrt{b}$ equal to $\sqrt{a + b}$? Explain your reasoning.

**b. Square Roots and Multiplication**

Is $\sqrt{4} \cdot \sqrt{9}$ equal to $\sqrt{4 \cdot 9}$?

In general, is $\sqrt{a} \cdot \sqrt{b}$ equal to $\sqrt{a \cdot b}$? Explain your reasoning.

**c. Square Roots and Subtraction**

Is $\sqrt{64} - \sqrt{36}$ equal to $\sqrt{64 - 36}$?

In general, is $\sqrt{a} - \sqrt{b}$ equal to $\sqrt{a - b}$? Explain your reasoning.

**d. Square Roots and Division**

Is $\dfrac{\sqrt{100}}{\sqrt{4}}$ equal to $\sqrt{\dfrac{100}{4}}$

In general, is $\dfrac{\sqrt{a}}{\sqrt{b}}$ equal to $\sqrt{\dfrac{a}{b}}$? Explain your reasoning.

## 9.1 Properties of Radicals (continued)

### 2 EXPLORATION: Writing Counterexamples

**Work with a partner.** A **counterexample** is an example that proves that a general statement is *not* true. For each general statement in Exploration 1 that is not true, write a counterexample different from the example given.

### Communicate Your Answer

**3.** How can you multiply and divide square roots?

**4.** Give an example of multiplying square roots and an example of dividing square roots that are different from the examples in Exploration 1.

**5.** Write an algebraic rule for each operation.

**a.** the product of square roots

**b.** the quotient of square roots

Name _____ Date _____

# 9.1 Notetaking with Vocabulary

**For use after Lesson 9.1**

**In your own words, write the meaning of each vocabulary term.**

counterexample

radical expression

simplest form

rationalizing the denominator

conjugates

like radicals

## Core Concepts

### 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 $a, b \geq 0$

### Notes:

Name_____ Date _____

## 9.1 Notetaking with Vocabulary (continued)

### 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 $b > 0$

### Notes:

## Extra Practice

**In Exercises 1–12, simplify the expression.**

**1.** $\sqrt{24}$ **2.** $-\sqrt{48}$ **3.** $\sqrt{162g^6}$ **4.** $-\sqrt{512h^7}$

**5.** $\sqrt{\frac{25}{64}}$ **6.** $-\sqrt{\frac{6}{49}}$ **7.** $-\sqrt{\frac{196}{r^4}}$ **8.** $\sqrt{\frac{49x^3}{64y^2}}$

**9.** $\sqrt[3]{-135}$ **10.** $\sqrt[3]{729}$ **11.** $-\sqrt[3]{-192x^5}$ **12.** $\sqrt[3]{\frac{12a^6}{512b^4}}$

Name _____ Date _____

## 9.1 Notetaking with Vocabulary (continued)

**In Exercises 13–20, simplify the expression.**

**13.** $\frac{\sqrt{15}}{\sqrt{500}}$ **14.** $\sqrt{\frac{8}{100}}$ **15.** $\frac{\sqrt{3x^2y^3}}{\sqrt{80xy^3}}$ **16.** $\frac{8}{\sqrt[3]{16}}$

**17.** $\frac{5}{-3 - 3\sqrt{3}}$ **18.** $\frac{3}{4 + 4\sqrt{5}}$ **19.** $\frac{4}{\sqrt{2} - 5\sqrt{3}}$ **20.** $\frac{\sqrt{5}}{\sqrt{3} + \sqrt{5}}$

**21.** The ratio of the length to the width of a *golden rectangle* is $\left(1 + \sqrt{5}\right) : 2$. The length of a golden rectangle is 62 meters. What is the width? Round your answer to the nearest meter.

**In Exercises 22–27, simplify the expression.**

**22.** $3\sqrt{8} + 3\sqrt{2}$ **23.** $2\sqrt{18} - 2\sqrt{20} - 2\sqrt{5}$ **24.** $3\sqrt{12} + 3\sqrt{18} + 2\sqrt{27}$

**25.** $2\sqrt{5}\left(\sqrt{6} + 2\right)$ **26.** $\left(\sqrt{7} - \sqrt{3}\right)\left(\sqrt{7} + \sqrt{3}\right)$ **27.** $\sqrt[3]{2}\left(\sqrt[3]{108} - \sqrt[3]{135}\right)$