# Practice Book

## 3 Practice and Apply

**Use Practice Book pp. 225–226**

| Assignment Guide | |
|---|---|
| **Decelerated** | 1–9, 10–17 |
| **Average** | 2–22 Even |
| **Accelerated** | 7–9, 14–24 |

■ Before assigning the exercises on Practice Book pages 225–226, work with students through the examples in the teaching display. Review the Quotient Property of Square Roots illustrated in the Think box in the second example.

■ Call attention to the direction line for exercises 1–9, in which the assumption is made that all variables represent nonnegative numbers. Discuss why that assumption is significant, eliciting that absolute value symbols are not needed.

***Errors Commonly Made***

Students may sometimes multiply only the coefficients of radicals and not the radicals themselves. Stress the need to multiply both. Have students write the entire multiplication and use the Commutative, Associative, and Distributive Properties, as necessary, to simplify the product.

■ For exercises 10–21, remind students that they must rationalize all denominators in order to write the quotients in simplest form. Elicit that the process of rationalizing a denominator uses the multiplicative identity.

### Problem Solving

■ Suggest that students draw diagrams for problems 22 and 23 before substituting into the given formulas.

### CHALLENGE

■ In exercise 24, remind students that the product of two binomials in the form $(a - b)(a + b)$ is $a^2 - b^2$.





# 9-3 Multiply and Divide Radical Expressions

Name ______________________ Date __________

Multiply: $-3\sqrt{5a}\,(2\sqrt{3a^2})(-4\sqrt{8a})$

$-3(2)(-4)\sqrt{5a} \bullet \sqrt{3a^2} \bullet \sqrt{8a}$ ← Use the Commutative and Associative Properties of Equality.

$24\sqrt{5a \bullet 3a^2 \bullet 8a}$ ← Use the Product Property of Square Roots.

$24\sqrt{120a^4}$ ← Multiply.

$24\sqrt{4a^4 \bullet 30}$ ← Factor out perfect squares.

$24\sqrt{4a^4} \bullet \sqrt{30}$ ← Use the Product Property of Square Roots.

$24(2a^2)\sqrt{30}$ ← Simplify.

$48a^2\sqrt{30}$ ← Simplify.

Simplify: $\sqrt{\frac{7}{6}}$

**Think**
$\sqrt{\frac{a}{b}} = \frac{\sqrt{a}}{\sqrt{b}}$, where $a \geq 0$ and $b > 0$.
So $\sqrt{\frac{7}{6}} = \frac{\sqrt{7}}{\sqrt{6}}$

$= \frac{\sqrt{7}}{\sqrt{6}} \bullet \frac{\sqrt{6}}{\sqrt{6}}$ ← Multiply by 1 in the form of $\frac{\sqrt{6}}{\sqrt{6}}$.

$= \frac{\sqrt{42}}{\sqrt{36}}$ ← Simplify.

$= \frac{\sqrt{42}}{6}$ ← Simplify.

Check students' work. Steps may vary.

**Simplify each radical expression. Assume that all variables represent nonnegative numbers.**

**1.** $3\sqrt{8} \bullet 2\sqrt{5} \bullet 4\sqrt{6}$

$3(2)(4)\sqrt{8} \bullet \sqrt{5} \bullet \sqrt{6}$
$24\sqrt{8(5)(6)}$
$24\sqrt{240}$
$24\sqrt{16(15)}$
$24\sqrt{16} \bullet \sqrt{15}$
$24(4)\sqrt{15}$
$96\sqrt{15}$

**2.** $2\sqrt{12} \bullet 4\sqrt{7} \bullet 5\sqrt{15}$

$2(4)(5)\sqrt{12} \bullet \sqrt{7} \bullet \sqrt{15}$
$40\sqrt{1260}$
$40\sqrt{36(35)}$
$40(6)\sqrt{35}$
$240\sqrt{35}$

**3.** $-5x\sqrt{2} \bullet 6\sqrt{10} \bullet 3\sqrt{6x^2}$

$-5x(6)(3)\sqrt{2} \bullet \sqrt{10} \bullet \sqrt{6x^2}$
$-90x\sqrt{120x^2}$
$-90x\sqrt{4x^2(30)}$
$-180x^2\sqrt{30}$

**4.** $-2\sqrt{3y^2} \bullet 5y\sqrt{8} \bullet 9\sqrt{14}$

$-2(5y)(9)\sqrt{3y^2} \bullet \sqrt{8} \bullet \sqrt{14}$
$-90y\sqrt{336y^2}$
$-90y\sqrt{16y^2(21)}$
$-360y^2\sqrt{21}$

**5.** $-3\sqrt{3x}\,(2\sqrt{5x} + 6\sqrt{6x})$

$-6\sqrt{15x^2} - 18\sqrt{18x^2}$
$-6x\sqrt{15} - 18x\sqrt{9 \bullet 2}$
$-6x\sqrt{15} - 54x\sqrt{2}$

**6.** $-2\sqrt{2a}\,(3\sqrt{12a} + 8\sqrt{5a})$

$-6\sqrt{24a^2} - 16\sqrt{10a^2}$
$-6a\sqrt{4 \bullet 6} - 16a\sqrt{10}$
$-12a\sqrt{6} - 16a\sqrt{10}$

**7.** $(\sqrt{3} + 4\sqrt{7})(5\sqrt{3} - 2\sqrt{7})$

$5(3) - 2\sqrt{21} + 20\sqrt{21} - 8(7)$
$15 - 56 + 18\sqrt{21}$
$-41 + 18\sqrt{21}$

**8.** $(\sqrt{5} + 3\sqrt{3})(2\sqrt{5} - 4\sqrt{3})$

$2(5) - 4\sqrt{15} + 6\sqrt{15} - 12(3)$
$10 - 36 + 2\sqrt{15}$
$-26 + 2\sqrt{15}$

**9.** $(7\sqrt{2} - x\sqrt{5})^2$

$(7\sqrt{2} - x\sqrt{5})(7\sqrt{2} - x\sqrt{5})$
$49(2) - 7x\sqrt{10} - 7x\sqrt{10} + 5x^2$
$98 - 14x\sqrt{10} + 5x^2$
$5x^2 - 14x\sqrt{10} + 98$

Simplify each radical expression. Assume that all variables represent nonnegative numbers.

**10.** $\frac{\sqrt{5}}{\sqrt{3}}$

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

$\frac{\sqrt{15}}{\sqrt{9}}$

$\frac{\sqrt{15}}{3}$

**11.** $\frac{\sqrt{11}}{\sqrt{7}}$

$\frac{\sqrt{11}}{\sqrt{7}} \cdot \frac{\sqrt{7}}{\sqrt{7}}$

$\frac{\sqrt{77}}{\sqrt{49}}$

$\frac{\sqrt{77}}{7}$

**12.** $\frac{\sqrt{24}}{\sqrt{8}}$

$\frac{\sqrt{24}}{\sqrt{8}} = \sqrt{\frac{24}{8}}$

$\sqrt{3}$

**13.** $\frac{\sqrt{42}}{\sqrt{7}}$

$\frac{\sqrt{42}}{\sqrt{7}} = \sqrt{\frac{42}{7}}$

$\sqrt{6}$

**14.** $\frac{7a}{\sqrt{8}}$

$\frac{7a}{\sqrt{8}} \cdot \frac{\sqrt{2}}{\sqrt{2}}$

$\frac{7a\sqrt{2}}{\sqrt{16}}$

$\frac{7a\sqrt{2}}{4}$

**15.** $\frac{5b}{\sqrt{27}}$

$\frac{5b}{\sqrt{27}} \cdot \frac{\sqrt{3}}{\sqrt{3}}$

$\frac{5b\sqrt{3}}{\sqrt{81}}$

$\frac{5b\sqrt{3}}{9}$

**16.** $\sqrt{\frac{12}{5}}$

$\frac{\sqrt{12}}{\sqrt{5}} \cdot \frac{\sqrt{5}}{\sqrt{5}}$

$\frac{\sqrt{60}}{5}; \frac{\sqrt{4 \cdot 15}}{5}$

$\frac{2\sqrt{15}}{5}$

**17.** $\sqrt{\frac{20}{7}}$

$\frac{\sqrt{20}}{\sqrt{7}} \cdot \frac{\sqrt{7}}{\sqrt{7}}$

$\frac{\sqrt{140}}{7}; \frac{\sqrt{4 \cdot 35}}{7}$

$\frac{2\sqrt{35}}{7}$

**18.** $\sqrt{\frac{6x}{7}}$

$\frac{\sqrt{6x}}{\sqrt{7}} \cdot \frac{\sqrt{7}}{\sqrt{7}}$

$\frac{\sqrt{42x}}{7}$

**19.** $\sqrt{\frac{5a}{11}}$

$\frac{\sqrt{5a}}{\sqrt{11}} \cdot \frac{\sqrt{11}}{\sqrt{11}}$

$\frac{\sqrt{55a}}{11}$

**20.** $\frac{2\sqrt{2a} + 4\sqrt{a}}{\sqrt{8a}}$

$\frac{2\sqrt{2a} + 4\sqrt{a}}{\sqrt{8a}} \cdot \frac{\sqrt{2a}}{\sqrt{2a}}$

$\frac{2\sqrt{4a^2} + 4\sqrt{2a^2}}{\sqrt{16a^2}}$

$\frac{4a + 4a\sqrt{2}}{4a}$

$1 + \sqrt{2}$

**21.** $\frac{5\sqrt{b} + 10\sqrt{b}}{\sqrt{5b}}$

$\frac{5\sqrt{b} + 10\sqrt{b}}{\sqrt{5b}} \cdot \frac{\sqrt{5b}}{\sqrt{5b}}$

$\frac{5\sqrt{5b^2} + 10\sqrt{5b^2}}{\sqrt{25b^2}}$

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

$3\sqrt{5}$

## Problem Solving

**22. Geometry** The length of a side of a square is $3\sqrt{8} + 6$. What is the area of the square? (*Hint:* Area $= s^2$)

Let $s$ = a side of the square

$s^2 = (3\sqrt{8} + 6)^2 = (3\sqrt{8} + 6)(3\sqrt{8} + 6)$
$= 9\sqrt{64} + 18\sqrt{8} + 18\sqrt{8} + 36$
$= 9(8) + 36 + 36\sqrt{8} = 108 + 36\sqrt{8}$
$= 108 + 36\sqrt{4} \cdot \sqrt{2} = 108 + 72\sqrt{2}$

The area is $108 + 72\sqrt{2}$ square units.

**23. Geometry** The base of a triangle is $5\sqrt{2} + \sqrt{3}$ and the height is $5\sqrt{2} - \sqrt{3}$. What is the area of the triangle? (*Hint:* Area $= \frac{1}{2}bh$)

$\frac{1}{2}bh = \frac{1}{2}(5\sqrt{2} + \sqrt{3})(5\sqrt{2} - \sqrt{3})$
$= \frac{1}{2}(25(2) - 3) = \frac{1}{2}(47) = \frac{47}{2} = 23.5$

The area is 23.5 square units.

## CHALLENGE

**24.** Simplify: $\frac{3\sqrt{2} + 6}{2\sqrt{5} + 3}$

(*Hint:* Multiply both numerator and denominator by $2\sqrt{5} - 3$.)

$\frac{3\sqrt{2} + 6}{2\sqrt{5} + 3} \cdot \frac{2\sqrt{5} - 3}{2\sqrt{5} - 3} = \frac{6\sqrt{10} - 9\sqrt{2} + 12\sqrt{5} - 18}{4\sqrt{25} - 6\sqrt{5} + 6\sqrt{5} - 9} = \frac{6\sqrt{10} - 9\sqrt{2} + 12\sqrt{5} - 18}{4(5) - 9} =$

$\frac{6\sqrt{10} - 9\sqrt{2} + 12\sqrt{5} - 18}{11}$



## Meeting Individual Needs

See page 225F.

## 4 Summarize/Assess

### Conceptual Thinking

- To assess whether students have conceptualized the lesson concepts, lead a class discussion in which they explain how the Commutative and Associative Properties, as well as the Product Property of Square Roots, are used to multiply radical expressions such as $\sqrt{2x} \cdot \sqrt{6x}$. $2x\sqrt{3}$ Then have them explain how the Distributive Property and FOIL method can be used to find products such as $(\sqrt{15} - \sqrt{6})^2$. $21 - 6\sqrt{10}$
- Discuss the meaning of rationalizing the denominator. Have students explain how to simplify expressions such as $\frac{\sqrt{5}}{\sqrt{6}}$ by doing so. $\frac{\sqrt{30}}{6}$

In their *Math Journals*, have students list the requirements that must be satisfied for a square-root expression to be in simplest form. Then have them simplify $\frac{3\sqrt{12}}{6\sqrt{18}}$. $\frac{\sqrt{6}}{6}$

## 5 Follow-Up

### Reteaching

- Review multiplying and dividing radical expressions. Have students work in small groups, and provide them with index cards. Each student should write several radical expressions, including monomials and binomials, on the cards. Then have groups mix up the cards and choose two at random. Members of each group should then work together to multiply the expressions. If both of the chosen cards show monomial expressions or if students choose one binomial expression and one monomial expression, they should also divide.

ONLINE See Chapter 9 Alternative Teaching Models.

**End of Lesson**

## Additional Resources

ONLINE www.progressinmathematics.com

- Meeting Individual Needs Activities
- Alternative Teaching Models
- Vocabulary Activities
- Audio Glossary
- Virtual Manipulatives