# EXERCISE SET 5.4

## Practice Exercises

*Evaluate each expression in Exercises 1–10.*

**1.** $\sqrt{9}$ **2.** $\sqrt{16}$ **3.** $\sqrt{25}$ **4.** $\sqrt{49}$

**5.** $\sqrt{64}$ **6.** $\sqrt{100}$ **7.** $\sqrt{121}$ **8.** $\sqrt{144}$

**9.** $\sqrt{169}$ **10.** $\sqrt{225}$

*In Exercises 11–16, use a calculator with a square root key to find a decimal approximation for each square root. Round the number displayed to the nearest* **a.** *tenth,* **b.** *hundredth,* **c.** *thousandth.*

**11.** $\sqrt{173}$ **12.** $\sqrt{3176}$ **13.** $\sqrt{17{,}761}$

**14.** $\sqrt{779{,}264}$ **15.** $\sqrt{\pi}$ **16.** $\sqrt{2\pi}$

*In Exercises 17–24, simplify the square root.*

**17.** $\sqrt{20}$ **18.** $\sqrt{50}$ **19.** $\sqrt{80}$ **20.** $\sqrt{12}$

**21.** $\sqrt{250}$ **22.** $\sqrt{192}$ **23.** $7\sqrt{28}$ **24.** $3\sqrt{52}$

*In Exercises 25–56, perform the indicated operation. Simplify the answer when possible.*

**25.** $\sqrt{7}\cdot\sqrt{6}$ **26.** $\sqrt{19}\cdot\sqrt{3}$ **27.** $\sqrt{6}\cdot\sqrt{6}$

**28.** $\sqrt{5}\cdot\sqrt{5}$ **29.** $\sqrt{3}\cdot\sqrt{6}$ **30.** $\sqrt{12}\cdot\sqrt{2}$

**31.** $\sqrt{2}\cdot\sqrt{26}$ **32.** $\sqrt{5}\cdot\sqrt{50}$ **33.** $\dfrac{\sqrt{54}}{\sqrt{6}}$

**34.** $\dfrac{\sqrt{75}}{\sqrt{3}}$ **35.** $\dfrac{\sqrt{90}}{\sqrt{2}}$ **36.** $\dfrac{\sqrt{60}}{\sqrt{3}}$

**37.** $\dfrac{-\sqrt{96}}{\sqrt{2}}$ **38.** $\dfrac{-\sqrt{150}}{\sqrt{3}}$ **39.** $7\sqrt{3}+6\sqrt{3}$

**40.** $8\sqrt{5}+11\sqrt{5}$ **41.** $4\sqrt{13}-6\sqrt{13}$

**42.** $6\sqrt{17}-8\sqrt{17}$ **43.** $\sqrt{5}+\sqrt{5}$

**44.** $\sqrt{3}+\sqrt{3}$ **45.** $4\sqrt{2}-5\sqrt{2}+8\sqrt{2}$

**46.** $6\sqrt{3}+8\sqrt{3}-16\sqrt{3}$ **47.** $\sqrt{5}+\sqrt{20}$

**48.** $\sqrt{3}+\sqrt{27}$ **49.** $\sqrt{50}-\sqrt{18}$

**50.** $\sqrt{63}-\sqrt{28}$ **51.** $3\sqrt{18}+5\sqrt{50}$

**52.** $4\sqrt{12}+2\sqrt{75}$ **53.** $\frac{1}{4}\sqrt{12}-\frac{1}{2}\sqrt{48}$

**54.** $\frac{1}{5}\sqrt{300}-\frac{2}{3}\sqrt{27}$ **55.** $3\sqrt{75}+2\sqrt{12}-2\sqrt{48}$

**56.** $2\sqrt{72}+3\sqrt{50}-\sqrt{128}$

*In Exercises 57–66, rationalize the denominator.*

**57.** $\dfrac{5}{\sqrt{3}}$ **58.** $\dfrac{12}{\sqrt{5}}$ **59.** $\dfrac{21}{\sqrt{7}}$

**60.** $\dfrac{30}{\sqrt{5}}$ **61.** $\dfrac{12}{\sqrt{30}}$ **62.** $\dfrac{15}{\sqrt{50}}$

**63.** $\dfrac{15}{\sqrt{12}}$ **64.** $\dfrac{13}{\sqrt{40}}$ **65.** $\sqrt{\dfrac{2}{5}}$ **66.** $\sqrt{\dfrac{5}{7}}$

## Practice Plus

*In Exercises 67–74, perform the indicated operations. Simplify the answer when possible.*

**67.** $3\sqrt{8}-\sqrt{32}+3\sqrt{72}-\sqrt{75}$

**68.** $3\sqrt{54}-2\sqrt{24}-\sqrt{96}+4\sqrt{63}$

**69.** $3\sqrt{7}-5\sqrt{14}\cdot\sqrt{2}$

**70.** $4\sqrt{2}-8\sqrt{10}\cdot\sqrt{5}$

**71.** $\dfrac{\sqrt{32}}{5}+\dfrac{\sqrt{18}}{7}$ **72.** $\dfrac{\sqrt{27}}{2}+\dfrac{\sqrt{75}}{7}$

**73.** $\dfrac{\sqrt{2}}{\sqrt{3}}+\dfrac{\sqrt{3}}{\sqrt{2}}$ **74.** $\dfrac{\sqrt{2}}{\sqrt{7}}+\dfrac{\sqrt{7}}{\sqrt{2}}$

## Application Exercises

*The formula*

$$d=\sqrt{\frac{3h}{2}}$$

*models the distance, d, in miles, that a person h feet high can see to the horizon. Use this formula to solve Exercises 75–76.*

**75.** The pool deck on a cruise ship is 72 feet above the water. How far can passengers on the pool deck see? Write the answer in simplified radical form. Then use the simplified radical form and a calculator to express the answer to the nearest tenth of a mile.

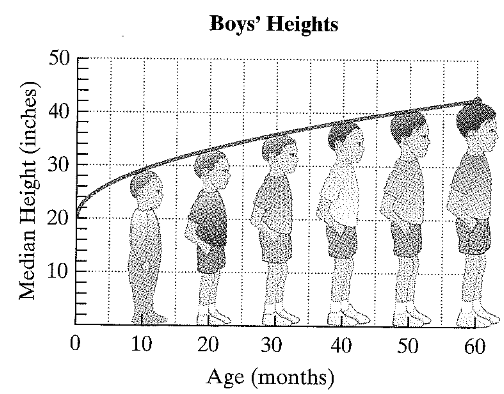
**76.** The captain of a cruise ship is on the star deck, which is 120 feet above the water. How far can the captain see? Write the answer in simplified radical form. Then use the simplified radical form and a calculator to express the answer to the nearest tenth of a mile.

*Police use the formula $v=2\sqrt{5L}$ to estimate the speed of a car, v, in miles per hour, based on the length, L, in feet, of its skid marks upon sudden braking on a dry asphalt road. Use the formula to solve Exercises 77–78.*

**77.** A motorist is involved in an accident. A police officer measures the car's skid marks to be 245 feet long. Estimate the speed at which the motorist was traveling before braking. If the posted speed limit is 50 miles per hour and the motorist tells the officer he was not speeding, should the officer believe him? Explain.

**78.** A motorist is involved in an accident. A police officer measures the car's skid marks to be 45 feet long. Estimate the speed at which the motorist was traveling before braking. If the posted speed limit is 35 miles per hour and the motorist tells the officer she was not speeding, should the officer believe her? Explain.

**79.** The graph shows the median heights for boys of various ages in the United States from birth through 60 months, or five years old.




*Source:* Laura Walther Nathanson, *The Portable Pediatrician for Parents*

89. Explain how to add square roots with the same radicand.

90. Explain how to add $\sqrt{3} + \sqrt{12}$.

91. Describe what it means to rationalize a denominator. Use $\frac{2}{\sqrt{5}}$ in your explanation.

### • Critical Thinking Exercises

92. Which one of the following is true?

a. The product of any two irrational numbers is always an irrational number.

b. $\sqrt{9} + \sqrt{16} = \sqrt{25}$

c. $\sqrt{\sqrt{16}} = 2$

d. $\frac{\sqrt{64}}{2} = \sqrt{32}$

*In Exercises 93–95, insert either < or > in the shaded area between the numbers to make each statement true.*

93. $\sqrt{2}$ ■ 1.5 **94.** $-\pi$ ■ $-3.5$ **95.** $-\frac{3.14}{2}$ ■ $-\frac{\pi}{2}$

**96.** How does doubling a number affect its square root?

**97.** Between which two consecutive integers is $-\sqrt{47}$?

**98.** Simplify: $\sqrt{2} + \sqrt{\frac{1}{2}}$.

**99.** Create a counterexample to show that the following statement is false: The difference between two irrational numbers is always an irrational number.

### • Group Exercises

*The following topics related to irrational numbers are appropriate for either individual or group research projects. A report should be given to the class on the researched topic.*

**100.** A History of How Irrational Numbers Developed

**101.** Pi: Its History, Applications, and Curiosities

**102.** Proving That $\sqrt{2}$ Is Irrational

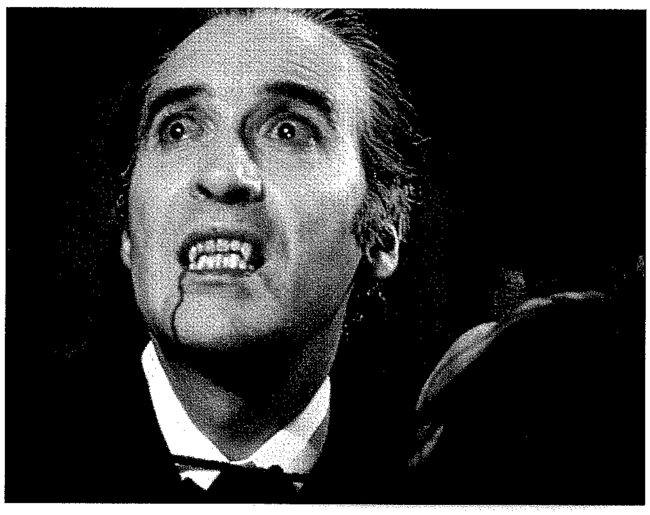
**103.** Imaginary Numbers: Their History, Applications, and Curiosities

**104.** The Golden Rectangle in Art and Architecture

# SECTION 5.5 • REAL NUMBERS AND THEIR PROPERTIES

OBJECTIVES

1. Recognize subsets of the real numbers.
2. Recognize properties of real numbers.



Horror films offer the pleasure of vicarious terror, of being safely scared.

1 Recognize subsets of the real numbers.

## The Set of Real Numbers

The vampire legend is death as seducer; he/she sucks our blood to take us to a perverse immortality. The vampire resembles us, but appears only at night, hidden among mortals. In this section, you will find vampires in the world of numbers. Mathematicians even use the labels *vampire* and *weird* to describe sets of numbers. However, the label that appears most frequently is *real*. The union of the rational numbers and the irrational numbers is the set of **real numbers**.

The sets that make up the real numbers are summarized in Table 5.2 on the next page. We refer to these sets as **subsets** of the real numbers, meaning that all elements in each subset are also elements in the set of real numbers.