GUIDED PRACTICE

Vocabulary Check ✓

1. Explain how you know when a rational expression is in simplified form.

Concept Check ✓

2. **ERROR ANALYSIS** Explain what is wrong with the simplification of the rational expression shown.

$$\frac{5x^2 + 8x + 3}{5x^2 + 5x} = \frac{(5x + 3)(x + 1)}{5x(x + 1)}$$
$$= \frac{5x + 3}{5x}$$
$$= \frac{3}{1} = 3$$

Skill Check ✓

If possible, simplify the rational expression.

3. $\frac{4x^2}{4x^3 + 12x}$
4. $\frac{x^2 + 4x - 5}{x^2 - 1}$
5. $\frac{x^2 + 10x - 4}{x^2 + 10x}$
6. $\frac{6x^2 - 4x - 3}{3x^2 + x}$
7. $\frac{x^2 - 9}{2x + 1}$
8. $\frac{2x^3 - 32x}{x^2 + 8x + 16}$

Perform the indicated operation. Simplify the result.

9. $\frac{16x^3}{5y^9} \cdot \frac{x^5y^8}{80x^3y}$
10. $\frac{7x^4y^3}{5xy} \cdot \frac{2x^7}{21y^5}$
11. $\frac{x^2 + x - 6}{2x^2} \cdot \frac{2x + 8}{x^2 + 7x + 12}$
12. $\frac{144}{4xy} \div \frac{54y^3}{3x^3y}$
13. $\frac{16xy}{3x^5y^5} \div \frac{8x^2}{9xy^7}$
14. $\frac{5x^2 + 10x}{x^2 - x - 6} \div \frac{15x^3 + 45x^2}{x^2 - 9}$

15. **SKYDIVING** Look back at Example 8 on page 557. Some skydivers wear "wings" to increase their surface area. Suppose a skydiver who is 65 inches tall is wearing wings that add $18x^2$ of surface area and an insignificant amount of volume. Calculate the skydiver's volume to surface area ratio with and without the wings.

PRACTICE AND APPLICATIONS

STUDENT HELP

Extra Practice to help you master skills is on p. 953.

SIMPLIFYING **If possible, simplify the rational expression.**

16. $\frac{3x^3}{12x^2 + 9x}$
17. $\frac{x^2 - x - 6}{x^2 + 8x + 16}$
18. $\frac{x^2 - 3x + 2}{x^2 + 5x - 6}$
19. $\frac{x^2 + 2x - 4}{x^2 + x - 6}$
20. $\frac{x^2 - 2x - 3}{x^2 - 7x + 12}$
21. $\frac{3x^2 - 3x - 6}{x^2 - 4}$
22. $\frac{x - 2}{x^3 - 8}$
23. $\frac{x^3 - 27}{x^3 + 3x^2 + 9x}$
24. $\frac{x^2 + 6x + 9}{x^2 - 9}$
25. $\frac{15x^2 - 8x - 18}{-20x^2 + 14x + 12}$
26. $\frac{x^3 - 2x^2 + x - 2}{3x^2 - 3x - 8}$
27. $\frac{x^3 + 3x^2 - 2x - 6}{x^3 + 27}$

MULTIPLYING **Multiply the rational expressions. Simplify the result.**

28. $\frac{4xy^3}{x^2y} \cdot \frac{y}{8x}$
29. $\frac{80x^4}{y^3} \cdot \frac{xy}{5x^2}$
30. $\frac{2x^2 - 10}{x + 1} \cdot \frac{x + 2}{3x^2 - 15}$
31. $\frac{x - 3}{2x - 8} \cdot \frac{6x^2 - 96}{x^2 - 9}$
32. $\frac{x^2 - x - 6}{4x^3} \cdot \frac{x + 1}{x^2 + 5x + 6}$
33. $\frac{2x^2 - 2}{x^2 - 6x - 7} \cdot (x^2 - 10x + 21)$
34. $\frac{x^3 + 5x^2 - x - 5}{x^2 - 25} \cdot (x + 1)$
35. $\frac{x - 3}{-x^3 + 3x^2} \cdot (x^2 + 2x + 1)$

STUDENT HELP

HOMEWORK HELP

Example 1: Exs. 16–27
Examples 2–4: Exs. 28–35, 44–49
Examples 5–7: Exs. 36–49
Example 8: Exs. 50–55

DIVIDING **Divide the rational expressions. Simplify the result.**

36. $\frac{32x^3y}{y^9} \div \frac{8x^4}{y^6}$

37. $\frac{2xyz}{x^2z^2} \div \frac{6y^3}{3xz}$

38. $\frac{3x^2 + x - 2}{x^2 + 3x + 2} \div \frac{2x}{x + 2}$

39. $\frac{x^2 - 14x + 48}{x^2 - 6x} \div (3x - 24)$

40. $\frac{2x^2 - 12x}{x^2 - 7x + 6} \div \frac{2x}{3x - 3}$

41. $\frac{x^2 + 8x + 16}{x + 2} \div \frac{x^2 + 6x + 8}{x^2 - 4}$

42. $\frac{x^2 + 6x - 7}{3x^2} \div \frac{x + 7}{6x}$

43. $(x^2 + 6x - 27) \div \frac{3x^2 + 27x}{x + 5}$

COMBINED OPERATIONS **Perform the indicated operations. Simplify the result.**

44. $(x - 5) \div \frac{x^2 - 11x + 30}{x^2 + 7x + 12} \cdot (x - 6)$

45. $\frac{x^2 - x - 12}{8x^2} \div \frac{x^3 + 3x^2}{8x^3 - 2x^2} \div \frac{4x - 1}{x + 2}$

46. $\frac{x^2 + 11x}{x - 2} \div (3x^2 + 6x) \cdot \frac{x^2 - 4}{x + 11}$

47. $\frac{2x^2 + x - 15}{2x^2 - 11x - 21} \cdot (6x + 9) \div \frac{2x - 5}{3x - 21}$

48. $(x^3 + 8) \cdot \frac{x - 2}{x^2 - 2x + 4} \div \frac{x^2 - 4}{x - 6}$

49. $\frac{x^2 + 12x + 20}{4x^2 - 9} \cdot \frac{6x^3 - 9x^2}{x^3 + 10x^2} \cdot (2x + 3)$

HEAT GENERATION **In Exercises 50 and 51, use the following information.**
Almost all of the energy generated by a long-distance runner is released in the form of heat. The rate of heat generation h_g and the rate of heat released h_r for a runner of height H can be modeled by

$$h_g = k_1H^3V^2 \qquad \text{and} \qquad h_r = k_2H^2$$

where k_1 and k_2 are constants and V is the runner's speed.

50. Write the ratio of heat generated to heat released.

51. When the ratio of heat generated to heat released equals 1, how is height related to velocity? Does this mean that a taller or a shorter runner has an advantage?

FARMLAND **In Exercises 52 and 53, use the following information.**
From 1987 to 1996, the total acres of farmland L (in millions) and the total number of farms F (in hundreds of thousands) in the United States can be modeled by

$$L = \frac{43.3t + 999}{0.0482t + 1} \qquad \text{and} \qquad F = \frac{0.101t^2 + 2.20}{0.0500t^2 + 1}$$

where t represents the number of years since 1987. ▶ Source: U.S. Bureau of the Census

52. Write a model for the average number of acres A per farm as a function of the year.

53. What was the average number of acres per farm in 1993?

WEIGHT IN GOLD **In Exercises 54 and 55, use the following information.**
From 1990 to 1996, the price P of gold (in dollars per ounce) and the weight W of gold mined (in millions of ounces) in the United States can be modeled by

$$P = \frac{53.4t^2 - 243t + 385}{0.00146t^3 + 0.122t^2 - 0.586t + 1}$$

$$W = -0.0112t^5 + 0.193t^4 - 1.17t^3 + 2.82t^2 - 1.76t + 10.4$$

where t represents the number of years since 1990. ▶ Source: U.S. Bureau of the Census

54. Write a model for the total value V of gold mined as a function of the year.

55. What was the total value of gold mined in the United States in 1994?

FOCUS ON CAREERS

REAL LIFE FARMER
In 1996 there were 1.3 million farmers and farm managers in the United States. In addition to knowing about crops and animals, farmers must keep up with changing technology and possess strong business skills.

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