4. $\frac{x^2-x-30}{3(x+3)}$; $x \neq -3, 2, 5$ **5.** $\frac{x-1}{x}$; $x \neq 0, -3$ **6.** $\frac{1}{4x^2y}$ **7.** $-\frac{x}{y^2}$ **8.** $\frac{x^2-8x+15}{(3x+1)^2}$

9. $\frac{x+4}{x-4}$

7.2 Exercises

Concept Check

Fill-in-the-Blank. Complete each sentence using information found in this section.

1. To multiply two or more rational expressions, first completely _____ each numerator and denominator.
2. To divide any two rational expressions, multiply the first fraction by the _____ of the second fraction (the divisor).
3. After a rational expression has been reduced, it is typical to multiply out the _____ and leave the _____ in factored form.
4. Remember that no rational expression can have a denominator with a value of _____.
5. When multiplying rational expressions, multiply the _____ and multiply the _____, keeping the expressions in factored form.

True/False. Determine whether each statement is true or false. If a statement is false, explain how it can be changed so the statement will be true. (**Note:** There may be more than one acceptable change.)

6. The reciprocal of $\frac{x}{x+3}$ is $\frac{-x-3}{x}$.
7. Dividing rational expressions is similar to dividing fractions.
8. There are no restrictions on the denominator $12x^2$.
9. Because $\frac{4x^2}{16x}$ reduces to $\frac{x}{4}$, there are no restrictions on the denominator.

Practice

Perform the indicated operations and reduce to lowest terms. Assume that no denominator has a value of 0.

1. $\frac{3ax^2}{4b} \cdot \frac{6b^2}{27x^2y}$
2. $\frac{18x^3}{5y^2} \cdot \frac{30y^3}{9x^4}$
3. $\frac{24x^3}{25y^2} \cdot \frac{10y^5}{18x}$
4. $\frac{16x^8}{3y^{11}} \cdot \frac{-21y^9}{10x^7}$
5. $\frac{x^2-9}{x^2+2x} \cdot \frac{x+2}{x-3}$
6. $\frac{16x^2-9}{3x^2-15x} \cdot \frac{6}{4x+3}$
7. $\frac{x^2+2x-3}{x^2+3x} \cdot \frac{x}{x+1}$
8. $\frac{4x+16}{x^2-16} \cdot \frac{x-4}{x}$

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9. $\dfrac{x^2+6x-16}{x^2-64}\cdot\dfrac{1}{2-x}$

10. $\dfrac{4-x^2}{x^2-4x+4}\cdot\dfrac{3}{x+2}$

11. $\dfrac{x^2-5x+6}{x^2-4x}\cdot\dfrac{x-4}{x-3}$

12. $\dfrac{2x^2+x-3}{x^2+4x}\cdot\dfrac{2x+8}{x-1}$

13. $\dfrac{2x^2+10x}{3x^2+5x+2}\cdot\dfrac{6x+4}{x^2}$

14. $\dfrac{x+3}{x^2-16}\cdot\dfrac{x^2-3x-4}{x^2-1}$

15. $\dfrac{x}{x^2+7x+12}\cdot\dfrac{x^2-2x-24}{x^2-7x+6}$

16. $\dfrac{x^2-2x-3}{x+5}\cdot\dfrac{x^2-5x-14}{x^2-x-6}$

17. $\dfrac{8-2x-x^2}{x^2-2x}\cdot\dfrac{x-4}{x^2-3x-4}$

18. $\dfrac{3x^2+21x}{x^2-49}\cdot\dfrac{x^2-5x+4}{x^2+3x-4}$

19. $\dfrac{(x-2y)^2}{x^2-5xy+6y^2}\cdot\dfrac{x+2y}{x^2-4xy+4y^2}$

20. $\dfrac{4x^2+6x}{x^2+3x-10}\cdot\dfrac{x^2+4x-12}{x^2+5x-6}$

21. $\dfrac{2x^2+5x+2}{3x^2+8x+4}\cdot\dfrac{3x^2-x-2}{4x^3-x}$

22. $\dfrac{x^2+5x}{4x^2+12x+9}\cdot\dfrac{6x^2+7x-3}{x^2+10x+25}$

23. $\dfrac{x+2}{x^2-1}\cdot\dfrac{x^2-2x+1}{x^2+x-2}$

24. $\dfrac{x^2-9}{2x+16}\cdot\dfrac{x^2+6x-16}{x^2-5x+6}$

25. $\dfrac{x-2}{x+5}\cdot\dfrac{x^2+7x+10}{x^2-4x+4}$

26. $\dfrac{2x^2-7x+3}{x^2-9}\cdot\dfrac{3x^2+8x-3}{6x^2+x-1}$

27. $\dfrac{12x^2y}{9xy^9}\div\dfrac{4x^4y}{x^2y^3}$

28. $\dfrac{35xy^3}{24x^3y}\div\dfrac{15x^4y^3}{84xy^4}$

29. $\dfrac{45xy^4}{21x^2y^2}\div\dfrac{40x^4}{112xy^5}$

30. $\dfrac{x-3}{15x}\div\dfrac{4x-12}{5}$

31. $\dfrac{x-1}{6x+6}\div\dfrac{2x-2}{x^2+x}$

32. $\dfrac{7x-14}{x^2}\div\dfrac{x^2-4}{x^3}$

33. $\dfrac{6x^2-54}{x^4}\div\dfrac{x-3}{x^2}$

34. $\dfrac{x^2-25}{6x+30}\div\dfrac{x-5}{x}$

35. $\dfrac{2x-1}{x^2+2x}\div\dfrac{10x^2-5x}{6x^2+12x}$

36. $\dfrac{x+3}{x^2+3x-4}\div\dfrac{x+2}{x^2+x-2}$

37. $\dfrac{6x^2-7x-3}{x^2-1}\div\dfrac{2x-3}{x-1}$

38. $\dfrac{x^2-9}{2x^2+7x+3}\div\dfrac{x^2-3x}{2x^2+11x+5}$

39. $\dfrac{x^2-6x+9}{x^2-4x+3}\div\dfrac{2x^2-7x+3}{x^2-3x+2}$

40. $\dfrac{x^3+2x^2}{x^2+11x+28}\div\dfrac{4x^2}{x+7}$

41. $\dfrac{2x+1}{4x-x^2}\div\dfrac{4x^2-1}{x^2-16}$

42. $\dfrac{x^2-4x+4}{x^2+5x+6}\div\dfrac{x^2+2x-8}{x^2+7x+12}$

43. $\dfrac{x^2-x-6}{x^2+6x+8}\div\dfrac{x^2-4x+3}{x^2+5x+4}$

44. $\dfrac{x^2-x-12}{6x^2-25x-9}\div\dfrac{x^2-6x+8}{3x^2-17x-6}$

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45. $\dfrac{6x^2+5x+1}{4x^3-3x^2} \div \dfrac{3x^2-2x-1}{3x^2-2x+1}$

46. $\dfrac{8x^2+2x-15}{3x^2+13x+4} \div \dfrac{2x^2+5x+3}{6x^2-x-1}$

47. $\dfrac{3x^2+13x+14}{4x^3-3x^2} \div \dfrac{6x^2-x-35}{4x^2+5x-6}$

48. $\dfrac{3x^2+2x}{9x^2-4} \div \dfrac{9x^2+6x-8}{9x^2-16}$

49. $\dfrac{x^2-8x+15}{x^2-9x+14} \div \dfrac{x^2+4x-21}{x-1}$

50. $\dfrac{6-11x-10x^2}{2x^2+x-3} \div \dfrac{5x^3-2x^2}{3x^2-5x+2}$

51. $\dfrac{x-6}{x^2-7x+6} \cdot \dfrac{x^2-3x}{x+3} \cdot \dfrac{x^2-9}{x^2-4x+3}$

52. $\dfrac{3x^2+11x+10}{2x^2+x-6} \cdot \dfrac{x^2+2x-3}{2x-1} \cdot \dfrac{2x-3}{3x^2+2x-5}$

53. $\dfrac{x^3+3x^2}{x^2+7x+12} \cdot \dfrac{2x^2+7x-4}{2x^2-x} \cdot \dfrac{x^2+4x-5}{2x^2-x-1}$

54. $\dfrac{x^2+2x-3}{x^2+10x+21} \cdot \dfrac{x^2+6x+5}{x^2-7x-8} \cdot \dfrac{x^2-x-56}{x^2-3x-40}$

55. $\dfrac{2x^2-5x+2}{4xy-2y+6x-3} \div \dfrac{xy-2y+3x-6}{2y^2+9y+9}$

56. $\dfrac{2xy-12x+y-6}{y^2-2y-24} \div \dfrac{2x^2+11x+5}{xy+5y+4x+20}$

Applications

Solve

57. Erik is building a cubby bookshelf; that is, a bookshelf divided into storage holes (cubbies) instead of shelves. He wants the height of the bookshelf to be $x^2 - 3x - 10$ and the width to be $x^2 + 5x + 6$. Each cubby hole in the bookshelf will have a height of $x + 3$ and a width of $x - 5$.

a. Write a rational expression to determine how many cubbies high the bookshelf will be.

b. Write a rational expression to determine how many cubbies wide the bookshelf will be.

c. Multiply the rational expressions from parts a. and b. (and reduce to lowest terms) to obtain a rational expression that gives the total number of cubbies in the entire bookshelf.

58. The station manager at WSTB The AlterNation is planning a giveaway for the month.
The monthly budget for the station is decided by the expression $60x^2 + 330x + 360$ and the budget is split evenly between $x + 3$ things, including the giveaway. During the giveaway, the prizes will be given to every $x + 3$ caller. The station usually receives $5x^2 + 65x + 180$ calls during giveaways.

a. Write a rational expression to determine how much of the budget will go to the giveaway.

b. Write a rational expression to determine how many callers will win prizes during the giveaway.

c. Find the rational expression used to determine the average amount the radio station can spend per prize by dividing the expression from part a. by the expression from part b. and reducing to lowest terms.

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