

Multiplying Rational Expressions

Name: _____ Date: _____ Score: _____ / 35

Quick Review

Multiplying rational expressions follows the same recipe as multiplying numeric fractions: $\frac{a}{b} \cdot \frac{c}{d} = \frac{ac}{bd}$. The polynomial version just has more opportunities to factor and cancel.

Step 1 – factor everything first. Multiply nothing until every polynomial is in factored form. This is where the savings live.

Step 2 – cancel common factors across the product. A factor in any numerator can cancel a matching factor in any denominator. Cross-cancel before multiplying out – the arithmetic stays clean.

Step 3 – state every restriction. Each original denominator contributes its restrictions, and so does each factor that cancels. Quick check: in $\frac{x^2 - 4}{x + 1} \cdot \frac{x + 1}{x + 2}$, the algebra cancels $x + 1$ and $x + 2$, but you still need $x \neq -1$ and $x \neq -2$ in the answer.

Sign-flipped factors. $a - b = -(b - a)$. So $\frac{x - 3}{2} \cdot \frac{4}{3 - x} = \frac{x - 3}{2} \cdot \frac{4}{-(x - 3)} = -\frac{4}{2} \cdot 1 = -2$. Always factor out the -1 before canceling.

Common slips. Trying to cancel terms across a sum or difference. Forgetting that canceled factors still set restrictions. Dropping a sign when one denominator is sign-flipped from the other.

PRACTICE

Factor every polynomial, cancel common factors across the product, then multiply. State every restriction.

1. $\frac{2}{x} \cdot \frac{x}{5}$ _____

2. Multiply $\frac{3x^2}{4} \cdot \frac{8}{x}$. The table evaluates the product at a few inputs. _____

x	1	2	3
$\frac{3x^2}{4} \cdot \frac{8}{x}$	6	12	18

3. Multiply $\frac{x^2 - 4}{x + 1} \cdot \frac{x + 1}{x + 2}$. The table samples the product away from the excluded values. _____

x	0	1	3
product	-2	-1	1

4. $\frac{x - 3}{x + 2} \cdot \frac{x + 2}{3 - x}$ _____

5. $\frac{x^2 - x - 6}{x + 4} \cdot \frac{x^2 + 3x - 4}{x^2 - 9}$ _____

6. $\frac{x^2 - 4}{x + 1} \cdot \frac{2 - x}{x - 2}$ _____

7. Multiply $\frac{x^2 + 5x + 6}{x^2 - 1} \cdot \frac{x - 1}{x + 3}$. The table evaluates the product at several inputs. _____

x	0	2	3
product	2	$\frac{4}{3}$	$\frac{5}{4}$

8. $\frac{x^2 - 1}{x^2 + 5x + 6} \cdot \frac{x + 3}{x - 1}$ _____

9. $\frac{x^2 - 4x}{x^2 - 16} \cdot \frac{x + 4}{x - 2}$ _____

10. $\frac{x^2 - 4}{x + 1} \cdot \frac{x + 1}{x - 2}$ _____



11. $\frac{6a}{b^2} \cdot \frac{b}{12a^2}$ _____

12. $\frac{x^2 + 2x + 1}{x^2 - 4} \cdot \frac{x - 2}{x + 1}$ _____

13. $\frac{x^2 - 9}{x^2 - x - 6} \cdot \frac{x + 2}{x + 3}$ _____

14. $\frac{x}{x^2 - 1} \cdot \frac{x - 1}{x^2 + x}$ _____

15. $\frac{2x^2 - 2}{x^2 + 3x + 2} \cdot \frac{x + 2}{4x - 4}$ _____

16. Mark TRUE or FALSE: $\frac{a - b}{b - a} = 1$. _____

17. $\frac{5}{x^2 - 1} \cdot (x + 1)$ _____

18. $\frac{x^2 - 25}{x + 5} \cdot \frac{1}{x - 5}$ _____

19. $\frac{2x + 10}{x^2 - 25} \cdot \frac{x - 5}{4}$ _____

20. $\frac{x^2 + 7x + 12}{x^2 - 9} \cdot \frac{x - 3}{x + 4}$ _____

◆ Word Problems21. A rectangle has dimensions $\frac{x^2 - 4}{x + 3}$ by $\frac{x + 3}{x - 2}$. Find the simplified area and state the restrictions. _____22. A scaling problem requires you to evaluate $\frac{x^2 - 1}{x + 2} \cdot \frac{2x + 4}{x - 1}$ at $x = 5$. Simplify first, then evaluate – and compare with plugging $x = 5$ in directly. _____23. A geometry problem produces $\frac{x^2 - 9}{x^2 + 4x + 3} \cdot \frac{x + 1}{x - 3}$. Simplify, state restrictions, and explain why the simplified answer is just a constant. _____24. A physics setup uses the ratio $\frac{x^2 + 5x + 6}{2x + 4} \cdot \frac{4}{x + 3}$. Simplify to a clean closed form. _____**Additional Practice**

25. Simplify $\frac{x^2 - 9}{x - 3}$. _____

26. Excluded value of $\frac{1}{x + 4}$. _____

27. Domain of $f(x) = \frac{x}{x - 5}$. _____

28. Multiply $\frac{x}{3} \cdot \frac{6}{x}$. _____

29. Divide $\frac{x^2}{5} \div \frac{x}{10}$. _____

30. Add $\frac{3}{x} + \frac{5}{x}$. _____



31. Subtract $\frac{7}{x-1} - \frac{2}{x-1}$. _____

32. Solve $\frac{1}{x} = 4$. _____

33. Solve $\frac{x+2}{x-1} = 3$. _____

34. Vertical asymptote of $y = \frac{4}{x+8}$. _____

35. Horizontal asymptote of $y = \frac{3x+1}{x-2}$. _____



Answer Keys

<p>1. $\frac{2}{5}, x \neq 0$</p> <p>2. $6x, x \neq 0$</p> <p>3. $x - 2, x \neq -1, -2$</p> <p>4. $-1, x \neq -2, 3$</p> <p>5. $\frac{(x+2)(x-1)}{x+3}, x \neq -4, -3, 3$</p> <p>6. $-\frac{(x-2)(x+2)}{x+1}, x \neq -1, 2$</p> <p>7. $\frac{x+2}{x+1}, x \neq \pm 1, -3$</p> <p>8. $\frac{x+1}{x+2}, x \neq -2, -3, 1$</p> <p>9. $\frac{x}{x-2}, x \neq -4, 4, 2$</p> <p>10. $x+2, x \neq -1, 2$</p> <p>11. $\frac{1}{2ab}, a \neq 0, b \neq 0$</p>	<p>12. $\frac{x+1}{x+2}, x \neq \pm 2, -1$</p> <p>13. $1, x \neq -2, -3, 3$</p> <p>14. $\frac{1}{(x+1)^2}, x \neq 0, \pm 1$</p> <p>15. $\frac{1}{2}, x \neq -2, -1, 1$</p> <p>16. FALSE</p> <p>17. $\frac{5}{x-1}, x \neq \pm 1$</p> <p>18. $1, x \neq \pm 5$</p> <p>19. $\frac{1}{2}, x \neq \pm 5$</p> <p>20. $1, x \neq -4, \pm 3$</p> <p>21. area = $x+2, x \neq -3, 2$</p> <p>22. $2(x+1) = 12$ at $x = 5$; direct: also 12</p> <p>23. $1, x \neq -3, -1, 3$</p> <p>24. $2, x \neq -2, -3$</p>
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Additional Practice Answers

<p>25. $x+3, x \neq 3$</p> <p>26. $x = -4$</p> <p>27. $x \neq 5$</p> <p>28. 2</p> <p>29. $2x$</p> <p>30. $\frac{8}{x}$</p>	<p>31. $\frac{5}{x-1}$</p> <p>32. $x = \frac{1}{4}$</p> <p>33. $x = \frac{5}{2}$</p> <p>34. $x = -8$</p> <p>35. $y = 3$</p>
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Additional Practice: Answers for all numbered items, including the added practice, are shown in the grid above.

Step-by-Step Explanations

1. The x on the bottom of the first fraction cancels the x on top of the second, leaving $\frac{2}{5}$. Even though the x vanishes, it once sat in a denominator, so keep the restriction $x \neq 0$ in your answer.
2. Multiply: $\frac{24x^2}{4x} = 6x$. (Coefficient: $24/4 = 6$; powers: $x^2/x = x$. The table values match $6x$ at $x = 1, 2, 3$.)
3. Factor the top: $x^2 - 4 = (x-2)(x+2)$. Cross-cancel the $(x+1)$ on the first bottom with the $(x+1)$ on the second top, and the $(x+2)$ on the first top with the $(x+2)$ on the second bottom. Left with $x-2$. Keep $x \neq -1, -2$: both sat in original denominators even though their factors cancelled. (The table agrees with $x-2$ at $x = 0, 1, 3$.)
4. Cancel $(x+2)$ across the product. The leftover is $\frac{x-3}{3-x}$; rewrite $3-x = -(x-3)$, so it becomes $\frac{x-3}{-(x-3)} = -1$. Sign-flipped factors like these always collapse to -1 . Keep $x \neq -2$ and $x \neq 3$ from the original denominators.
5. Factor every piece: $x^2 - x - 6 = (x-3)(x+2)$, $x^2 + 3x - 4 = (x+4)(x-1)$, $x^2 - 9 = (x-3)(x+3)$. The $(x+4)$ on top of the second fraction cancels the $(x+4)$ denominator of the first, and one $(x-3)$ cancels the other. What remains is $\frac{(x+2)(x-1)}{x+3}$. List $x \neq -4, -3, 3$ from the original denominators.
6. Keep the rule visible: $x^2 - 4 = (x-2)(x+2)$ and $2-x = -(x-2)$. Multiply: $\frac{(x-2)(x+2)}{(x-2)(x+2)} \cdot \frac{-(x-2)}{-(x-2)(x+2)} = -\frac{x+2}{x+3}$. One $(x-2)$ cancels but the other stays. That gives a quick check on the answer.
7. Factor: $x^2 + 5x + 6 = (x+2)(x+3)$, $x^2 - 1 = (x-1)(x+1)$. Cancel $(x+3)$ and $(x-1)$. (The table matches $\frac{x+2}{x+1}$ at $x = 0, 2, 3$.)
8. Factor: $x^2 - 1 = (x-1)(x+1)$ and $x^2 + 5x + 6 = (x+2)(x+3)$. The $(x-1)$ on the second bottom cancels the $(x-1)$ up top, and the $(x+3)$ factors cancel, leaving $\frac{x+1}{x+2}$. Keep $x \neq -2, -3, 1$ from the original denominators.
9. Factor: $x^2 - 4x = x(x-4)$ and $x^2 - 16 = (x-4)(x+4)$. The $(x+4)$ on the second top cancels the $(x+4)$ on the first bottom, and the $(x-4)$ factors cancel too, leaving $\frac{x}{x-2}$. Keep $x \neq -4, 4, 2$ from the original denominators.
10. Factor the top of the first fraction: $x^2 - 4 = (x-2)(x+2)$. The $(x+1)$ on the first bottom cancels the $(x+1)$ on the second top, and the $(x-2)$ on the second bottom cancels the $(x-2)$ up top. Left with $x+2$. Keep $x \neq -1, 2$ from the original denominators.
11. Coefficients: $\frac{6}{12} = \frac{1}{2}$. Powers of a : $\frac{a}{a^2} = \frac{1}{a}$. Powers of b : $\frac{b}{b^2} = \frac{1}{b}$. Combine: $\frac{1}{2ab}$.
12. Start with the key idea: $x^2 + 2x + 1 = (x+1)^2$ and $x^2 - 4 = (x-2)(x+2)$. The $(x-2)$ on the second top cancels the $(x-2)$ below, and the $(x+1)$ on the second bottom cancels one of the two $(x+1)$ factors up top. One $(x+1)$ survives on top, giving $\frac{x+1}{x+2}$. Keep $x \neq \pm 2, -1$. That gives a quick check on the answer.
13. Factor: $x^2 - 9 = (x-3)(x+3)$ and $x^2 - x - 6 = (x-3)(x+2)$. Writing it out, $\frac{(x-3)(x+3)}{(x-3)(x+2)} \cdot \frac{x+2}{x+3}$ - every factor pairs off, so the product is 1. Still keep $x \neq -2, -3, 3$ from the original denominators; the expression equals 1 everywhere *except* those points.
14. Keep the rule visible: $x^2 - 1 = (x-1)(x+1)$, $x^2 + x = x(x+1)$. Cancel x and $(x-1)$. Left with $\frac{1}{(x+1)(x+1)} = \frac{1}{(x+1)^2}$. That gives a quick check



on the answer.

15. One steady path is: $2x^2 - 2 = 2(x-1)(x+1)$; $x^2 + 3x + 2 = (x+1)(x+2)$; $4x - 4 = 4(x-1)$. Cancel $(x-1)$, $(x+1)$, $(x+2)$, and reduce $\frac{2}{4}$ to $\frac{1}{2}$. That gives a quick check on the answer.

16. Sign-flipped factors give -1 , not 1 . $b - a = -(a - b)$, so the quotient is -1 (for $a \neq b$).

17. A careful way to see it: Treat $x + 1$ as $\frac{x+1}{1}$. Factor $x^2 - 1 = (x-1)(x+1)$ and cancel. That gives a quick check on the answer.

18. Factor $x^2 - 25 = (x-5)(x+5)$. The $(x+5)$ on top cancels the $(x+5)$ below, and the $(x-5)$ on the second bottom cancels the $(x-5)$ up top. Both factors clear, leaving 1 . Keep $x \neq \pm 5$ from the original denominators.

19. One steady path is: $2x + 10 = 2(x+5)$; $x^2 - 25 = (x-5)(x+5)$. Cancel $(x+5)$ and $(x-5)$. Reduce $\frac{2}{4} = \frac{1}{2}$. That gives a quick check on the answer.

20. Factor: $x^2 + 7x + 12 = (x+3)(x+4)$ and $x^2 - 9 = (x-3)(x+3)$. The $(x-3)$ on the second top cancels the $(x-3)$ below, the $(x+4)$ on the second bottom cancels the $(x+4)$ up top, and one $(x+3)$ cancels the other. Everything clears, so the product is 1 . Keep $x \neq -4, \pm 3$.

21. Area = $\frac{x^2 - 4}{x+3} \cdot \frac{x+3}{x-2} = \frac{(x-2)(x+2)}{x+3} \cdot \frac{x+3}{x-2} = x+2$. Cancel $(x-2)$ and $(x+3)$. Restrictions: $x \neq -3$ (from the first denominator) and $x \neq 2$ (from

the second). At $x = 5$ the formula gives area = $7 -$ and the original product is $\frac{21}{8} \cdot \frac{8}{3} = 7$. Match.

22. Factor: $x^2 - 1 = (x-1)(x+1)$, $2x + 4 = 2(x+2)$. Product: $\frac{(x-1)(x+1)}{x+2} \cdot \frac{2(x+2)}{x-1} = 2(x+1)$. At $x = 5$: $2(6) = 12$. Direct plug:

$\frac{24}{7} \cdot \frac{14}{4} = \frac{336}{28} = 12$. Match. (Simplifying first saves a lot of arithmetic, especially when the factors involved cancel cleanly.)

23. Factor: $x^2 - 9 = (x-3)(x+3)$ and $x^2 + 4x + 3 = (x+1)(x+3)$. Then $\frac{(x-3)(x+3)}{(x+1)(x+3)} \cdot \frac{x+1}{x-3} = 1$. Every factor matches up – the constant 1 emerges because the two fractions were already reciprocals in disguise. Restrictions: $x \neq -3$ and $x \neq -1$ (original denominators) and $x \neq 3$ (from the second numerator's matching denominator). The constant answer is valid only on the allowed domain – which means the original expression equals 1 everywhere except those four exclusions.

24. Factor: $x^2 + 5x + 6 = (x+2)(x+3)$ and $2x + 4 = 2(x+2)$. Then $\frac{(x+2)(x+3)}{2(x+2)} \cdot \frac{4}{x+3} = \frac{4}{2} = 2$. The variable disappears because every factor cancels in pairs. Restrictions: $x \neq -2$ and $x \neq -3$ (from the original denominators). On its domain the expression equals the constant 2 . (Sanity check at $x = 1$: $\frac{12}{6} \cdot \frac{4}{4} = 2 \cdot 1 = 2$.)



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