

# 12-4 Multiplying and Dividing Rational Expressions

Warm Up

Lesson Presentation

Lesson Quiz

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# 12-4 Multiplying and Dividing Rational Expressions

**Warm Up**

**Multiply.**

1.  $2x^2(x + 3)$

$2x^3 + 6x^2$

2.  $(x - 5)(3x + 7)$

$3x^2 - 8x - 35$

3.  $3x(x^2 + 2x + 2)$

$3x^3 + 6x^2 + 6x$

4. Simplify  $\frac{12x^{12}y^{10}}{40x^5y^{15}}$

$\frac{3x^7}{10y^5}$

KCF

$\frac{2}{3} \cdot \frac{2}{7}$

5.  $\frac{2}{3} \div \frac{1}{2} = \frac{4}{3}$

6.  $\frac{3}{5} \div \frac{11}{3} = \frac{9}{55}$

7.  $\frac{2}{5} \div \frac{7}{15} = \frac{6}{7}$

8.  $\frac{3}{4} \div \frac{9}{16} = \frac{4}{3}$

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**12-4** Multiplying and Dividing  
Rational Expressions***Objective***

Multiply and divide rational expressions.

**12-4** Multiplying and Dividing  
Rational Expressions

The rules for multiplying and dividing rational expressions are the same as the rules for multiplying fractions. You multiply the numerators, and you multiply the denominators.

**12-4** Multiplying and Dividing Rational Expressions

Multiplying Rational Expressions

$$\frac{a}{b} \cdot \frac{c}{d} = \frac{ac}{bd}$$

Dividing Rational Expressions

$$\frac{a}{b} \div \frac{c}{d} = \frac{a}{b} \cdot \frac{d}{c} = \frac{ad}{bc}$$

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**12-4** Multiplying and Dividing Rational Expressions

There are two methods for simplifying rational expressions. You can **simplify first** by dividing out and **then multiply** the remaining factors. You can also **multiply first** and **then simplify**. Using either method will result in the same answer.

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## 12-4 Multiplying and Dividing Rational Expressions

### Example 1A: Multiplying Rational Expressions

Multiply. Simplify your answer.

$$\frac{(c-1)}{2} \cdot \frac{4}{(3c-3)}$$

$$\frac{4(c-1)}{2(3c-3)} = \frac{4(c-1)}{2 \cdot 3(c-1)} = \frac{4(c-1)}{6(c-1)}$$

$$= \frac{\cancel{4}(c-1)}{3 \cdot \cancel{6}(c-1)} = \frac{2}{3}$$

Cancel: diagonals  
Top → Bottom

$$\frac{\cancel{c}^1 \cancel{1}^2}{\cancel{2}^1} \cdot \frac{\cancel{4}^2}{\cancel{3}^1 \cancel{(c-1)}^1}$$

$$\frac{2}{3}$$

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## 12-4 Multiplying and Dividing Rational Expressions

### Example 1B: Multiplying Rational Expressions

Multiply. Simplify your answer.

$$\frac{8x^2y^3}{5yz^2} \cdot \frac{10y^2z^2}{16y^3}$$

$$\frac{(8)(10)x^2(y^3 \cdot y^2)z^2}{(16)(5)(y \cdot y^3)z^2}$$

$$\frac{80x^2y^{\cancel{5}}}{80y^{\cancel{4}}}$$

$$x^2yz^0$$

$$x^2y$$

$$\frac{\cancel{8}x^2\cancel{y}^3}{\cancel{5}y\cancel{z}^2} \cdot \frac{\cancel{10}y^{\cancel{2}}\cancel{z}^2}{\cancel{16}y^{\cancel{3}}}$$

$$x^2y$$

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## 12-4 Multiplying and Dividing Rational Expressions

$$1. \frac{\overset{1}{\cancel{x+3}}}{5x} \cdot \frac{\overset{2}{\cancel{4x+12}}}{\cancel{4(x+3)}}$$

$$\frac{1}{5x} \cdot \frac{1}{2} = \frac{1}{10x}$$

$$2. \frac{\cancel{3x}}{x+3} \cdot \frac{\overset{(x+2)(x+3)}{\cancel{x^2+5x+6}}}{\cancel{x}}$$

$$\frac{3(x+2)\cancel{(x+3)}}{\cancel{(x+3)}}$$

$$\underline{\underline{3(x+2)}} \text{ or } \underline{\underline{3x+6}}$$

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## 12-4 Multiplying and Dividing Rational Expressions

### Check It Out! Example 1a

Multiply. Simplify your answer.

$$\frac{(c-4)}{5} \cdot \frac{45}{(-4c+16)}$$

$$\frac{45(c-4)}{(5)(-4)(c-4)}$$

$$\frac{\cancel{45}(c-4)}{\cancel{-20}(c-4)}$$

$$-\frac{9}{4}$$

Multiply the numerators and the denominators. Arrange the expression so like variables are together.

Simplify.

Divide out common factors. Use properties of exponents.

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## 12-4 Multiplying and Dividing Rational Expressions

### Check It Out! Example 1b

Multiply. Simplify your answer.

$$\frac{5y^3z}{3xy^2z} \cdot \frac{2x^4y^2}{4xy} = \frac{5x^2y^4}{6}$$

The image shows the multiplication of two rational expressions with handwritten annotations. The first fraction is  $\frac{5y^3z}{3xy^2z}$  and the second is  $\frac{2x^4y^2}{4xy}$ . Red annotations show the cancellation of  $y^2$  and  $z$  in the first fraction, and  $x^3$  and  $y$  in the second fraction. The final simplified result is  $\frac{5x^2y^4}{6}$ .

## 12-4 Multiplying and Dividing Rational Expressions

### Remember!

Just as you can write an integer as a fraction, you can write any expression as a rational expression by writing it with a denominator of 1.

## 12-4 Multiplying and Dividing Rational Expressions

### Check It Out! Example 3a

Multiply  $\frac{n-5}{n^2+4n} \cdot \frac{n^2+8n+16}{n^2-3n-10}$ . Simplify your answer.

Simplify first.

$$\frac{n-5}{n(n+4)} \cdot \frac{(n+4)(n+4)}{(n+2)(n-5)} \quad \text{Factor.}$$

$$\frac{\cancel{n-5}^1 \cdot \cancel{(n+4)}^1 (n+4)}{n \cancel{(n+4)}^1 (n+2) \cancel{(n-5)}^1} \quad \text{Divide out common factors.}$$

Then multiply.

$$\frac{\overset{n+4}{\cancel{1(n+4)}} \cdot \frac{n+4}{n^2+2n}}{\quad} \quad \text{Simplify.}$$

## 12-4 Multiplying and Dividing Rational Expressions

### Multiply Rational Expressions

$$\frac{\cancel{(n+3)} \cancel{(n-4)} (n+2)(n+1)}{n^2-n-12} \cdot \frac{n^2+3n+2}{n^2+2n-24} \cdot \frac{n^2-4n-21}{(n+6)\cancel{(n-4)}}$$

$$\frac{(n+2)(n+1)}{(n+6)(n-7)} = \frac{n^2+3n+2}{n^2-n-42}$$

## 12-4 Multiplying and Dividing Rational Expressions

### Example 4A: Dividing by Rational Expressions and Polynomials

Divide. Simplify your answer.

$$\frac{2}{g} \div \frac{g+4}{g^2}$$

$$\frac{2}{g} \cdot \frac{g^2}{g+4}$$

$$\frac{2(g^2)}{g(g+4)}$$

$$\frac{2g^{\cancel{2}^1}}{\cancel{g}^1(g+4)}$$

$$\frac{2g}{g+4}$$
  

$$\frac{1-n^2}{n} \div \frac{n-1}{n^2-4n}$$

$$\frac{(1+n)^{\cancel{1}}(1-n)}{\cancel{n}} \cdot \frac{\cancel{n}(n-4)}{n-1}$$

$$\frac{-1(\cancel{n-1})(n+1)}{1} \cdot \frac{1(\cancel{n-1})}{\cancel{n-1}}$$

$$-1(n+1)(n-4)$$

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## 12-4 Multiplying and Dividing Rational Expressions

### Example 4C: Dividing by Rational Expressions and Polynomials

Divide. Simplify your answer.

$$\frac{4xy^2}{\cancel{y}} \div \frac{(2x^2+6x)}{1}$$

$$\frac{4xy}{1} \cdot \frac{1}{2x^2+6x}$$

$$\frac{\cancel{4}xy}{1} \cdot \frac{1}{\cancel{2}y(x+3)}$$

$$\frac{2y}{x+3}$$

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## 12-4 Multiplying and Dividing Rational Expressions

KCF

### Check It Out! Example 4b

Divide. Simplify your answer.

$$\frac{18vw^2}{6v} \div \frac{3v^2x^4}{2w^4x}$$

Be sure not to cancel diagonally unless in mult. form

$$\frac{18vw^2}{6v} \cdot \frac{2w^4x}{3v^2x^4}$$

Write as multiplication by the reciprocal.

$$\frac{18vw^2(2w^4x)}{6v(3v^2x^4)}$$

Multiply the numerators and the denominators and cancel common factors.

$$\frac{\cancel{36}^2 \cancel{v} w^6 \cancel{x}}{\cancel{6}^1 v \cancel{3}^3 v^2 \cancel{x}^3}$$

$$\frac{2w^6}{v^2x^3}$$

Simplify.

## 12-4 Multiplying and Dividing Rational Expressions

### Lesson Quiz: Part I

Multiply. Simplify your answer.

1.  $\frac{b-2}{3} \cdot \frac{12}{2b-4}$      2.  $\frac{3m^2}{n} \cdot \frac{m^3}{2n^2}$

3.  $\frac{3x^2+3x}{6y} \cdot \frac{12y^2}{7x^2y+7xy}$

Divide. Simplify your answer.

4.  $\frac{3}{b} \div \frac{b+1}{2b}$      5.  $\frac{4gh^3}{h} \div (2g^2 - 8g)$

**12-4** **Multiplying and Dividing  
Rational Expressions**

**Homework**

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16, 19, 20