

## 2.4 Skill Builder

### Simplifying Fractions

To simplify a fraction, divide the numerator and denominator by their common factors.

To simplify  $\frac{5 \times 5 \times 5 \times 5}{5 \times 5}$ :

*This fraction shows repeated multiplication.*

Divide the numerator and denominator by their common factors:  $5 \times 5$ :

$$\begin{aligned} & \frac{\overset{1}{\cancel{5}} \times \overset{1}{\cancel{5}} \times 5 \times 5}{\cancel{5}^1 \times \cancel{5}^1} \\ &= \frac{5 \times 5}{1} \\ &= 25 \end{aligned}$$

### Check

1. Simplify each fraction.

a)  $\frac{3 \times 3 \times 3}{3}$

$$\begin{aligned} &= \\ &= \end{aligned}$$

b)  $\frac{8 \times 8 \times 8 \times 8 \times 8}{8 \times 8 \times 8 \times 8 \times 8}$

$$=$$

c)  $\frac{5 \times 5 \times 5 \times 5 \times 5}{5 \times 5 \times 5}$

$$\begin{aligned} &= \\ &= \\ &= \end{aligned}$$

d)  $\frac{2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2}{2 \times 2 \times 2 \times 2 \times 2}$

$$\begin{aligned} &= \\ &= \\ &= \end{aligned}$$

*What are the common factors?*

## 2.4 Exponent Laws I

**FOCUS** Understand and apply the exponent laws for products and quotients of powers.

Multiply  $3^2 \times 3^4$ .

$$3^2 \times 3^4$$

Write as repeated multiplication.

$$= (\underbrace{3 \times 3}) \times (\underbrace{3 \times 3 \times 3 \times 3})$$

2 factors of 3      4 factors of 3

$$= \underbrace{3 \times 3 \times 3 \times 3 \times 3 \times 3}_{6 \text{ factors of } 3}$$

$$= 3^6$$

Base      Exponent

$$\text{So, } 3^2 \times 3^4 = 3^6$$

Look at the pattern in the exponents.

$$2 + 4 = 6$$

$$\begin{aligned} \text{We write: } 3^2 \times 3^4 &= 3^{(2+4)} \\ &= 3^6 \end{aligned}$$

This relationship is true when you multiply any 2 powers with the same base.

### Exponent Law for a Product of Powers

To multiply powers with the same base, add the exponents.

#### Example 1 Simplifying Products with the Same Base

Write as a power.

**a)**  $5^3 \times 5^4$

**b)**  $(-6)^2 \times (-6)^3$

**c)**  $(7^2)(7)$

#### Solution

**a)** The powers have the same base: 5

Use the exponent law for products: add the exponents.

$$\begin{aligned} 5^3 \times 5^4 &= 5^{(3+4)} \\ &= 5^7 \end{aligned}$$

*To check your work,  
you can write the  
powers as repeated  
multiplication.*

**b)** The powers have the same base:  $-6$

$$(-6)^2 \times (-6)^3 = (-6)^{(2+3)} \quad \text{Add the exponents.}$$
$$= (-6)^5$$

**c)**  $(7^2)(7) = 7^2 \times 7^1$

$$= 7^{(2+1)}$$
$$= 7^3$$

Use the exponent law for products.  
Add the exponents.

7 can be written  
as  $7^1$ .

## Check

1. Write as a power.

**a)**  $2^5 \times 2^4 = 2^{(\quad + \quad)}$

$$= 2^{\quad}$$

**b)**  $5^2 \times 5^5 = 5^{\quad}$

$$= 5^{\quad}$$

**c)**  $(-3)^2 \times (-3)^3 = \underline{\hspace{2cm}}$

$$= \underline{\hspace{2cm}}$$

**d)**  $10^5 \times 10 = \underline{\hspace{2cm}}$

$$= \underline{\hspace{2cm}}$$

Divide  $3^4 \div 3^2$ .

$$3^4 \div 3^2 = \frac{3^4}{3^2}$$

$$= \frac{3 \times 3 \times 3 \times 3}{3 \times 3}$$

$$= \frac{\cancel{3}^1 \times \cancel{3}^1 \times 3 \times 3}{\cancel{3}^1 \times \cancel{3}^1}$$

$$= \frac{3 \times 3}{1}$$

$$= 3 \times 3$$

$$= 3^2$$

So,  $3^4 \div 3^2 = 3^2$

$$\begin{array}{ccc} \downarrow & \downarrow & \downarrow \\ 4 & - & 2 = 2 \end{array}$$

Simplify.

We can show division  
in fraction form.

Look at the pattern in the exponents.

We write:  $3^4 \div 3^2 = 3^{(4-2)}$

$$= 3^2$$

This relationship is true when you divide any 2 powers with the same base.

## Exponent Law for a Quotient of Powers

To divide powers with the same base, subtract the exponents.

### Example 2 Simplifying Quotients with the Same Base

Write as a power.

a)  $4^5 \div 4^3$

b)  $(-2)^7 \div (-2)^2$

#### Solution

Use the exponent law for quotients: subtract the exponents.

$$\begin{aligned}\text{a) } 4^5 \div 4^3 &= 4^{(5-3)} \\ &= 4^2\end{aligned}$$

The powers have the same base: 4

$$\begin{aligned}\text{b) } (-2)^7 \div (-2)^2 &= (-2)^{(7-2)} \\ &= (-2)^5\end{aligned}$$

To check your work, you can write the powers as repeated multiplication.

The powers have the same base: -2

#### Check

1. Write as a power.

$$\begin{aligned}\text{a) } (-5)^6 \div (-5)^3 &= (-5)\_\_\_\_\_\_ \\ &= \_\_\_\_\_\_\end{aligned}$$

$$\begin{aligned}\text{b) } \frac{(-3)^9}{(-3)^5} &= (-3)\_\_\_\_\_\_ \\ &= \_\_\_\_\_\_\end{aligned}$$

$$\begin{aligned}\text{c) } 8^4 \div 8^3 &= \_\_\_\_\_\_ \\ &= \_\_\_\_\_\_\end{aligned}$$

$$\begin{aligned}\text{d) } 9^8 \div 9^2 &= \_\_\_\_\_\_ \\ &= \_\_\_\_\_\_\end{aligned}$$

$$\frac{(-3)^9}{(-3)^5} \text{ is the same as } (-3)^9 \div (-3)^5$$

**Example 3****Evaluating Expressions Using Exponent Laws**

Evaluate.

**a)**  $2^2 \times 2^3 \div 2^4$

**b)**  $(-2)^5 \div (-2)^3 \times (-2)$

**Solution**

**a)**  $2^2 \times 2^3 \div 2^4$   
 $= 2^{(2+3)} \div 2^4$   
 $= 2^5 \div 2^4$   
 $= 2^{(5-4)}$   
 $= 2^1$   
 $= 2$

Add the exponents of the 2 powers that are multiplied.  
Then, subtract the exponent of the power that is divided.

**b)**  $(-2)^5 \div (-2)^3 \times (-2)$   
 $= (-2)^{(5-3)} \times (-2)$   
 $= (-2)^2 \times (-2)$   
 $= (-2)^{(2+1)}$   
 $= (-2)^{(3)}$   
 $= (-2)(-2)(-2)$   
 $= -8$

Subtract the exponents of the 2 powers that are divided.

Multiply: add the exponents.

**Check****1.** Evaluate.

**a)**  $4 \times 4^3 \div 4^2 = 4(\underline{\quad} + \underline{\quad}) \div 4^2$   
 $= 4\underline{\quad} \div 4^2$   
 $= 4(\underline{\quad} - \underline{\quad})$   
 $= 4\underline{\quad}$   
 $= \underline{\quad}$

**b)**  $(-3) \div (-3) \times (-3)$   
 $= (-3)\underline{\quad} \times (-3)$   
 $= (-3)\underline{\quad} \times (-3)$   
 $= (-3)\underline{\quad}$   
 $= (-3)\underline{\quad}$   
 $= \underline{\quad}$

$(-3) = (-3)^1$

## Practice

1. Write each product as a single power.

a)  $7^6 \times 7^2 = 7(\underline{\quad} + \underline{\quad})$   
 $= 7\underline{\quad}$

b)  $(-4)^5 \times (-4)^3 = (-4)\underline{\quad}$   
 $= (-4)\underline{\quad}$

c)  $(-2) \times (-2)^3 = \underline{\quad}$   
 $= \underline{\quad}$

d)  $10^5 \times 10^5 = \underline{\quad}$   
 $= \underline{\quad}$

e)  $7^0 \times 7^1 = \underline{\quad}$   
 $= \underline{\quad}$

f)  $(-3)^4 \times (-3)^5 = \underline{\quad}$   
 $= \underline{\quad}$

To multiply powers with the same base, add the exponents.

2. Write each quotient as a power.

a)  $(-3)^5 \div (-3)^2 = (-3)(\underline{\quad} - \underline{\quad})$   
 $= (-3)\underline{\quad}$

b)  $5^6 \div 5^4 = 5\underline{\quad}$   
 $= 5\underline{\quad}$

c)  $\frac{4^7}{4^4} = 4\underline{\quad}$   
 $= 4\underline{\quad}$

d)  $\frac{5^8}{5^6} = \underline{\quad}$   
 $= \underline{\quad}$

e)  $6^4 \div 6^4 = \underline{\quad}$   
 $= \underline{\quad}$

f)  $\frac{(-6)^8}{(-6)^7} = \underline{\quad}$   
 $= \underline{\quad}$

To divide powers with the same base, subtract the exponents.

3. Write as a single power.

a)  $2^3 \times 2^4 \times 2^5 = 2(\underline{\quad} + \underline{\quad}) \times 2^5$   
 $= 2\underline{\quad} \times 2^5$   
 $= 2\underline{\quad}$   
 $= 2\underline{\quad}$

b)  $\frac{3^2 \times 3^2}{3^2 \times 3^2} = \frac{3\underline{\quad}}{3\underline{\quad}}$   
 $= \frac{3\underline{\quad}}{3\underline{\quad}}$   
 $= \underline{\quad}$   
 $= \underline{\quad}$

Which exponent law should you use?

c)  $10^3 \times 10^5 \div 10^2 = \underline{\quad} \div 10^2$   
 $= \underline{\quad} \div 10^2$   
 $= \underline{\quad}$   
 $= \underline{\quad}$

d)  $(-1)^9 \div (-1)^5 \times (-1)^0$   
 $= \underline{\quad} \times (-1)^0$   
 $= \underline{\quad} \times (-1)^0$   
 $= \underline{\quad}$   
 $= \underline{\quad}$



4. Simplify, then evaluate.

$$\begin{aligned} \text{a) } (-3)^1 \times (-3)^2 \times 2 \\ = \underline{\hspace{2cm}} \times 2 \\ = \underline{\hspace{2cm}} \times 2 \\ = \underline{\hspace{2cm}} \times 2 \\ = \underline{\hspace{2cm}} \end{aligned}$$

$$\begin{aligned} \text{b) } 9^9 \div 9^7 \times 9^0 &= \underline{\hspace{2cm}} \times 9^0 \\ &= \underline{\hspace{2cm}} \times 9^0 \\ &= \underline{\hspace{2cm}} \\ &= \underline{\hspace{2cm}} \\ &= \underline{\hspace{2cm}} \end{aligned}$$

See if you can use  
the exponent  
laws to simplify.

$$\begin{aligned} \text{c) } \frac{5^2}{5^0} &= \underline{\hspace{2cm}} \\ &= \underline{\hspace{2cm}} \\ &= \underline{\hspace{2cm}} \end{aligned}$$

$$\begin{aligned} \text{d) } \frac{5^5}{5^4} \times 5 &= 5 \underline{\hspace{1cm}} \times 5 \\ &= 5 \underline{\hspace{1cm}} \times 5 \\ &= 5 \underline{\hspace{1cm}} \\ &= 5 \underline{\hspace{1cm}} \\ &= \underline{\hspace{2cm}} \end{aligned}$$

5. Identify any errors and correct them.

a)  $4^3 \times 4^5 = 4^8$

\_\_\_\_\_

\_\_\_\_\_

b)  $2^5 \times 2^5 = 2^{25}$

\_\_\_\_\_

\_\_\_\_\_

c)  $(-3)^6 \div (-3)^2 = (-3)^3$

\_\_\_\_\_

\_\_\_\_\_

d)  $7^0 \times 7^2 = 7^0$

\_\_\_\_\_

\_\_\_\_\_

e)  $6^2 + 6^2 = 6^4$

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

f)  $10^6 \div 10 = 10^6$

\_\_\_\_\_

\_\_\_\_\_

g)  $2^3 \times 5^2 = 10^5$

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