

LESSON
7.1**Study Guide**

For use with pages 385–391

**CA Standards**
NS 2.3
AF 2.1**GOAL****Use exponent properties to simplify expressions involving products.****Product of Powers Property**

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

Power of a Power Property

To simplify a power of a power, multiply exponents.

Power of a Product Property

To simplify a power of a product, find the power of each factor and multiply.

EXAMPLE 1 **Using the Product of Powers Property****Simplify the expression.**

$$\begin{aligned} \text{a. } 5^6 \cdot 5^4 &= 5^{6+4} \\ &= 5^{10} \end{aligned}$$

Product of powers property

Add exponents.

$$\begin{aligned} \text{b. } x^2 \cdot x^7 &= x^{2+7} \\ &= x^9 \end{aligned}$$

Product of powers property

Add exponents.

$$\begin{aligned} \text{c. } w^{-3} \cdot w^{-5} &= w^{-3+(-5)} \\ &= w^{-8} \\ &= \frac{1}{w^8} \end{aligned}$$

Product of powers property

Add exponents.

Definition of negative exponent: $a^{-n} = \frac{1}{a^n}$ **EXAMPLE 2** **Using the Power of a Power Property****Simplify the expression.**

$$\begin{aligned} \text{a. } (8^6)^3 &= 8^{6 \cdot 3} \\ &= 8^{18} \end{aligned}$$

Power of a power property

Multiply exponents.

$$\begin{aligned} \text{b. } (-6^7)^5 &= (-6)^{7 \cdot 5} \\ &= (-6)^{35} \end{aligned}$$

Power of a power property

Multiply exponents.

$$\begin{aligned} \text{c. } (y^5)^{-3} &= y^{5 \cdot (-3)} \\ &= y^{-15} \\ &= \frac{1}{y^{15}} \end{aligned}$$

Power of a power property

Multiply exponents.

Definition of negative exponent

$$\begin{aligned} \text{d. } (d^{-2})^{-4} &= d^{-2 \cdot (-4)} \\ &= d^8 \end{aligned}$$

Power of a power property

Multiply exponents.

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Exercises for Examples 1 and 2

Simplify the expression.

1. $6^7 \cdot 6^3$

2. $2^4 \cdot 2^{-5}$

3. $v^2 \cdot v^8$

4. $n^{-5} \cdot n^3$

5. $(-3)^4 \cdot (-3)^{-3}$

6. $w^{-5} \cdot w^{-7}$

7. $(4^4)^2$

8. $[(-5)^{-3}]^{-3}$

9. $(s^2)^{-5}$

10. $(y^{-3})^4$

11. $[(-a)^{-2}]^{-7}$

12. $(h^{-6})^{-2}$

EXAMPLE 3 **Using the Power of a Product Property**

Simplify the expression.

$$\begin{aligned} \text{a. } (4a)^3 &= 4^3 \cdot a^3 \\ &= 64a^3 \end{aligned}$$

Power of a product property

Evaluate power.

$$\begin{aligned} \text{b. } (xy)^5 &= x^5 \cdot y^5 \\ &= x^5 y^5 \end{aligned}$$

Power of a product property

Write without multiplication symbol.

$$\begin{aligned} \text{c. } (-jk)^{-4} &= (-1)^{-4} \cdot j^{-4} \cdot k^{-4} \\ &= \frac{1}{(-1)^4} \cdot \frac{1}{j^4} \cdot \frac{1}{k^4} \\ &= \frac{1}{1} \cdot \frac{1}{j^4} \cdot \frac{1}{k^4} \\ &= \frac{1}{j^4 k^4} \end{aligned}$$

Power of a product property

Definition of negative exponent

Evaluate power.

Simplify.

Exercises for Example 3

Simplify the expression.

13. $(2b)^4$

14. $(3g)^{-3}$

15. $(ad)^8$

16. $(mn)^{-5}$

17. $(-2x)^4$

18. $(-st)^{-7}$

LESSON
7.2**Study Guide**

For use with pages 392–398

CA Standards

NS 2.3

AF 2.1

GOAL

Use exponent properties involving quotients.

Quotient of Powers Property

To divide two powers with the same nonzero base, subtract the exponent of the denominator from the exponent of the numerator.

Power of a Quotient Property

To find the power of a quotient, find the power of the numerator and the power of the denominator, then divide.

EXAMPLE 1**Using the Quotient of Powers Property**

Simplify the expression.

$$\begin{aligned} \text{a. } \frac{3^7}{3^4} &= 3^{7-4} \\ &= 3^3 \end{aligned}$$

Quotient of powers property

Subtract exponents.

$$\begin{aligned} \text{b. } \frac{x^9}{x^5} &= x^{9-5} \\ &= x^4 \end{aligned}$$

Quotient of powers property

Subtract exponents.

$$\begin{aligned} \text{c. } \frac{w^{-8}}{w^{-6}} &= w^{-8-(-6)} \\ &= w^{-2} \\ &= \frac{1}{w^2} \end{aligned}$$

Quotient of powers property

Subtract exponents.

Definition of negative exponent: $a^{-n} = \frac{1}{a^n}$ **EXAMPLE 2****Using the Power of a Quotient Property**

Simplify the expression.

$$\begin{aligned} \text{a. } \left(\frac{8}{-3}\right)^5 &= \frac{8^5}{(-3)^5} \\ &= -\frac{32,768}{243} \end{aligned}$$

Power of a quotient property

Evaluate powers.

$$\begin{aligned} \text{b. } \left(\frac{4}{y}\right)^3 &= \frac{4^3}{y^3} \\ &= \frac{64}{y^3} \end{aligned}$$

Power of a quotient property

Evaluate power.

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c. $\left(\frac{z}{2}\right)^{-6} = \frac{z^{-6}}{2^{-6}}$	Power of a quotient property
$= \frac{1}{2^6} z^6$	Definition of negative exponents
$= \frac{1}{z^6} \cdot \frac{2^6}{1}$	Multiply by reciprocal.
$= \frac{64}{z^6}$	Evaluate power and simplify.

Exercises for Examples 1 and 2

Simplify the expression.

1. $\frac{4^9}{4^2}$

2. $\frac{y^5}{y^{-4}}$

3. $\frac{a^{-3}}{a^{-2}}$

4. $\left(\frac{-5}{6}\right)^4$

5. $\left(\frac{-3}{x}\right)^5$

6. $\left(\frac{h}{3}\right)^{-3}$

EXAMPLE 3 **Dividing Numbers in Scientific Notation**

In 2004, about 2.25×10^7 people lived in Texas. That same year, about 6.55×10^5 people lived in Alaska. The number of people who lived in Texas was about how many times the number who lived in Alaska?

Solution

Find the ratio of the number of people who lived in Texas to the number who lived in Alaska.

$\frac{2.25 \times 10^7}{6.55 \times 10^5} = \frac{2.25}{6.55} \times \frac{10^7}{10^5}$	Write quotient as a product.
$\approx 0.344 \times 10^{7-5}$	Quotient of powers product
$= 0.344 \times 10^2$	Simplify exponent.
$= 34.4$	Write in standard form.

In 2004, the number of people who lived in Texas was about 34.4 times the number of people who lived in Alaska.

Exercise for Example 3

7. The area of Alaska is 3.65×10^8 acres. The area of Texas is 1.68×10^8 acres. The area of Alaska is how many times the area of Texas?

LESSON
7.3**Study Guide**

For use with pages 399–404

**CA Standards**
AF 2.2**GOAL****Apply properties of exponents to monomials.****VOCABULARY**

A **monomial** is a number, a variable, or a product of a number and one or more variables with whole number exponents.

EXAMPLE 1 **Finding Products of Monomials****Simplify the expression.**

$$\begin{aligned} \text{a. } (2x^2y^3)(-4x^5y^2) &= 2 \cdot x^2 \cdot y^3 \cdot (-4) \cdot x^5 \cdot y^2 \\ &= 2 \cdot (-4) \cdot x^2 \cdot x^5 \cdot y^3 \cdot y^2 \\ &= -8 \cdot x^2 \cdot x^5 \cdot y^3 \cdot y^2 \\ &= -8x^7 \cdot y^3 \cdot y^2 \\ &= -8x^7y^5 \end{aligned}$$

Expand the expression.

Regroup factors.

Multiply coefficients.

Product of powers property

Product of powers property

$$\begin{aligned} \text{b. } (3s^5t^4)^2 &= 3^2 \cdot (s^5)^2 \cdot (t^4)^2 \\ &= 9 \cdot (s^5)^2 \cdot (t^4)^2 \\ &= 9s^{10} \cdot (t^4)^2 \\ &= 9s^{10}t^8 \end{aligned}$$

Power of a product property

Evaluate power of coefficient.

Power of a power property

Power of a power property

EXAMPLE 2 **Finding Quotients of Monomials****Simplify the expression.**

$$\begin{aligned} \text{a. } \frac{24v^6}{3v^5} &= \frac{24}{3} \cdot \frac{v^6}{v^5} \\ &= 8 \cdot \frac{v^6}{v^5} \\ &= 8v \end{aligned}$$

Expand the expression.

Divide coefficients.

Quotient of powers property

$$\begin{aligned} \text{b. } \frac{18a^4b^3}{6a^3b^5} &= \frac{18}{6} \cdot \frac{a^4}{a^3} \cdot \frac{b^3}{b^5} \\ &= 3 \cdot \frac{a^4}{a^3} \cdot \frac{b^3}{b^5} \\ &= 3 \cdot a \cdot b^{-2} \\ &= \frac{3a}{b^2} \end{aligned}$$

Expand the expression.

Divide coefficients.

Quotient of powers property

Definition of negative exponent

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$$\begin{aligned} \text{c. } \left(\frac{c^2}{d^3}\right)^4 &= \frac{(c^2)^4}{(d^3)^4} \\ &= \frac{c^8}{d^{12}} \end{aligned}$$

Power of a quotient property

Power of a power property

Exercises for Examples 1 and 2

Simplify the expression.

1. $(3f)(4f^7)$

2. $(8m^3)(-3m)$

3. $(-7p^5q)(2pq^4)$

4. $(6j^3k^2)(-jk^4)$

5. $(2g^4h^3)^5$

6. $(-4u^2v^6)^3$

7. $\frac{14w^5}{7w^3}$

8. $\frac{50a^7}{5a}$

9. $\frac{21p^4q^6}{3p^5q^5}$

10. $\frac{15a^5b^8}{45a^9b^9}$

11. $\left(\frac{c^3}{d}\right)^4$

12. $\left(\frac{h^2}{t^4}\right)^5$

EXAMPLE 3 **Simplifying Square Roots**

Simplify the expression.

$$\begin{aligned} \text{a. } \sqrt{25p^2} &= \sqrt{5^2 \cdot p^2} \\ &= \sqrt{5^2} \cdot \sqrt{p^2} \\ &= 5p \end{aligned}$$

Write 25 as 5^2 .

Product property of square roots

Simplify square roots of squared expressions.

$$\begin{aligned} \text{b. } \sqrt{12x^2} &= \sqrt{2^2 \cdot 3 \cdot x^2} \\ &= \sqrt{2^2} \cdot \sqrt{3} \cdot \sqrt{x^2} \\ &= 2 \cdot \sqrt{3} \cdot x \\ &= 2x\sqrt{3} \end{aligned}$$

Factor greatest perfect square from 12.

Product property of square roots

Simplify square roots of squared expressions.

Commutative property

$$\begin{aligned} \text{c. } \sqrt{a^8b^{10}} &= \sqrt{(a^4)^2 \cdot (b^5)^2} \\ &= \sqrt{(a^4)^2} \cdot \sqrt{(b^5)^2} \\ &= a^4b^5 \end{aligned}$$

Write a^8 and b^{10} as squares of expressions.

Product property of square roots

Simplify square roots of squared expressions.

Exercises for Example 3

13. $\sqrt{z^6}$

14. $\sqrt{u^8}$

15. $\sqrt{81h^2}$

16. $\sqrt{64g^4}$

17. $\sqrt{32y^6}$

18. $\sqrt{72w^4}$

19. $\sqrt{44s^8t^{12}}$

20. $\sqrt{98x^{14}y^6}$