

Exponent Properties Involving Products

Goal: Use exponent properties to simplify expressions involving products.

Product of Powers Property

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

Algebra $a^m \cdot a^n = a^{m+n}$

Numbers $4^5 \cdot 4^3 = 4^{5+3} = 4^8$

EXAMPLE 1 Using the Product of Powers Property

Simplify the expression.

a. $x^2 \cdot x^8 = x^{2+8}$
 $= x^{10}$

Product of powers property

Add exponents.

b. $y^4 \cdot y^{-6} = y^{4+(-6)}$
 $= y^{-2}$
 $= \frac{1}{y^2}$

Product of powers property

Add exponents.

Definition of negative exponent: $a^{-n} = \frac{1}{a^n}$

Remember that the simplified form of an expression must contain no negative exponents.

Power of a Power Property

Words To simplify a power of a power, **multiply** exponents.

Algebra $(a^m)^n = a^{mn}$

Numbers $(4^2)^3 = 4^{2 \cdot 3} = 4^6$

EXAMPLE 2 Using the Power of a Power Property

a. $(8^2)^3 = 8^{2 \cdot 3}$ Power of a power property
 $= 8^6$ Multiply exponents.

b. $(b^{-4})^6 = b^{-4 \cdot 6}$ Power of a power property
 $= b^{-24}$ Multiply exponents.
 $= \frac{1}{b^{24}}$ Definition of negative exponent.

c. $(x^{-5})^{-2} = x^{-5 \cdot (-2)}$ Power of a power property
 $= x^{10}$ Multiply exponents.

Guided Practice Simplify the expression.

1. $3^2 \cdot 3$	2. $d^5 \cdot d^3$	3. $k^{-1} \cdot k^{-4}$
4. $r^6 \cdot r^{-7}$	5. $(9^4)^2$	6. $(p^3)^6$
7. $(y^{-2})^8$	8. $(z^{-3})^{-3}$	9. $[(-4)^7]^2$

Power of a Power Property

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

Algebra $(ab)^m = a^m \cdot b^m$

Numbers $(2 \cdot 3)^4 = 2^4 \cdot 3^4$

EXAMPLE 3 Using the Power of a Product Property

a. $(2z)^5 = 2^{\boxed{5}} \cdot z^{\boxed{5}}$ Power of a product property
 $= \boxed{32} z^{\boxed{5}}$ Evaluate power.

b. $(ab)^6 = a^{\boxed{6}} \cdot b^{\boxed{6}}$ Power of a product property
 $= \boxed{a^6 b^6}$ Write without multiplication symbol.

c. $(-3x)^{-3} = (-3)^{\boxed{-3}} \cdot x^{\boxed{-3}}$ Power of a product property
 $= \frac{\boxed{1}}{\boxed{(-3)^3}} \cdot \frac{\boxed{1}}{\boxed{x^3}}$ Definition of negative exponent
 $= \frac{\boxed{1}}{\boxed{-27}} \cdot \frac{\boxed{1}}{\boxed{x^3}}$ Evaluate power.
 $= \frac{\boxed{-1}}{\boxed{27x^3}}$ Simplify.

Guided Practice Simplify the expression.

10. $(4g)^4$

11. $(cd)^{10}$

12. $(-10w)^{-1}$

Need help with scientific notation? See page 201 of your textbook.

Recall that there are 3600 seconds, or 3.6×10^3 seconds, in 1 hour.

Homework

EXAMPLE 4 Multiplying Numbers in Scientific Notation

Space Shuttle A space shuttle can reach a speed of about 2.5×10^4 feet per second. If the space shuttle maintains this speed, how far can it travel in 1 hour?

Solution

To find how far the space shuttle can travel in one hour, evaluate the product $(2.5 \times 10^4) \times (3.6 \times 10^3)$.

$$\begin{aligned} & (2.5 \times 10^4) \times (3.6 \times 10^3) \\ &= \boxed{2.5} \times \boxed{3.6} \times \boxed{10^4} \times \boxed{10^3} \quad \text{Commutative property of multiplication} \\ &= (\boxed{2.5 \times 3.6}) \times (\boxed{10^4 \times 10^3}) \quad \text{Associative property of multiplication} \\ &= \boxed{9} \times 10^{\boxed{7}} \quad \text{Product of powers property} \end{aligned}$$

Answer The space shuttle can travel about $\boxed{9 \times 10^7}$ feet in one hour.