

7-4

Power Rules

$$1. (4^3)^2 = (4 \cdot 4 \cdot 4)(4 \cdot 4 \cdot 4) = 4^6$$

$$2. (2^5)^3 = 2^5 \cdot 2^5 \cdot 2^5 = 2^{15} = 2^{5 \cdot 3}$$

$$3. (x^4)^3 = x^{4 \cdot 3} = x^{12}$$

Key Concepts

Raising a Power to a Power

To raise a power to a power, multiply the exponents.

Arithmetic

$$(2^5)^3 = 2^{(5 \cdot 3)} = 2^{15}$$

Algebra

$$(a^m)^n = a^{(m \cdot n)}, \text{ where } m \text{ and } n \text{ are integers.}$$

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EXAMPLE**Raising a Power to a Power**

Write each expression using a single exponent.

a. $(3^{-4})^5$

$$= 3^{-4 \cdot 5}$$

← Multiply the exponents. →

$$= 3^{-20}$$

← Simplify the exponent. →

$$= \frac{1}{3^{20}}$$

b. $(x^{-2})^{-3}$

$$= x^{-2 \cdot -3}$$

$$= x^6$$

✓ **Check Understanding**

1 Write each expression using a single exponent.

a. $(5^3)^{-2}$ 5^{-6}

b. $(12^{-3})^{-2}$ 12^6

c. $(10^2)^9$ 10^{18}

d. **Reasoning** For $y > 1$, which is greater, $y^4 \cdot y^5$ or $(y^4)^5$? Explain.

$$\frac{1}{5^6}$$

$$5^{-1} = \frac{1}{5^1}$$

$$y^{4+5}$$

$$y^{4 \cdot 5}$$

$$y^9 < y^{20}$$

You can raise a product to a power using repeated multiplication.

$$(2w)^3 = 2w \ 2w \ 2w$$

← Write out the factors of the power.

$$= 2 \cdot 2 \cdot 2 \cdot w \cdot w \cdot w$$

← Use the Commutative Property to rearrange the factors.

$$= 2^3 w^3$$

← Write the factors as a product.

Notice that $(2w)^3 = 2^3 w^3$. This result suggests the following rule.

Key Concepts

Raising a Product to a Power

To raise a product to a power, raise each factor to the power.

Arithmetic

$$(3 \cdot 5)^2 = 3^2 \cdot 5^2$$

Algebra

$$(\underline{a} \underline{b})^m = \underline{a}^m \underline{b}^m, \text{ where } m \text{ is an integer.}$$

2**EXAMPLE****Raising a Product to a Power**Simplify $(3y^3)^2$.

$$(3y^3)^2 = 3^2(y^3)^2$$

$$= 9y^6$$

← Raise each factor to the second power.

← Multiply the exponents. Simplify.

✓ **Check Understanding****2** Simplify each expression.

a. $(10x)^2$

$10^2 x^2$

$100x^2$

b. $(4u^5)^2$

$4^2 (u^5)^2$

$16u^{10}$

c. $(2a^3b)^3$

$2^3 (a^3)^3 b^3$

$8a^9b^3$