

Power Rules

You can use the rules for multiplying exponents to simplify an expression such as $(4^3)^2$.

$$\begin{aligned}(4^3)^2 &= 4^3 \cdot 4^3 \\ &= 4^{(3+3)} = 4^6\end{aligned}$$

Since $6 = 3 \cdot 2$, $(4^3)^2 = 4^{(3 \cdot 2)} = 4^6$. This suggests that to raise a power to a power, you multiply the exponents.

EXAMPLE Raising a Power to a Power

1 Write each expression using a single exponent.

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

$$\begin{aligned}(3^{-4})^5 &= 3^{(-4 \cdot 5)} \\ &= 3^{-20}\end{aligned}$$

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

$$\begin{aligned}(x^{-2})^{-3} &= x^{(-2 \cdot -3)} \\ &= x^6\end{aligned}$$

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

$$\begin{aligned}(2w)^3 &= (2w) \cdot (2w) \cdot (2w) \quad \leftarrow \text{Write out the factors of the power.} \\ &= 2 \cdot 2 \cdot 2 \cdot w \cdot w \cdot w \quad \leftarrow \text{Use the Commutative Property to rearrange the factors.} \\ &= 2^3 \cdot w^3 = 2^3w^3 \quad \leftarrow \text{Write the factors as a product.}\end{aligned}$$

Notice that $(2w)^3 = 2^3w^3$. This suggests that to raise a product to a power, you raise each factor to the power.

EXAMPLE Raising a Product to a Power

2 Simplify $(3y^3)^2$.

$$\begin{aligned}(3y^3)^2 &= 3^2(y^3)^2 \\ &= 3^2y^6 = 9y^6\end{aligned}$$

Exercises

Write each expression using a single exponent.

1. $(3^3)^7$

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

3. $(w^{-2})^{-6}$

4. $(r^2)^3$

Simplify each expression.

5. $(3x)^2$

6. $(a^2b^3)^4$

7. $(10x^5)^2$

8. $(y^2 \cdot 2^2)^4$