

Power Laws

A power is a product of identical factors.

$$\begin{array}{c} \text{exponent} \\ \downarrow \\ \text{base} \rightarrow 2^4 = \underbrace{2 \cdot 2 \cdot 2 \cdot 2}_{\text{power}} \end{array}$$

A power can be written in exponential form or expanded form.

Exponential Form →

Expanded Form →

Negative Signs and Bases

If a negative sign is in brackets, it is part of the base and the exponent must be applied to it.

$$(-3)^2 = (-3)(-3)$$

$$(-3)^2 = 9$$

If a negative sign is not in brackets, it is not part of the base and the exponent does not apply to it.

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

$$-3^3 = -9$$

Power Law Name	Power Law	Explanation and Examples
The Product Law	When multiplying powers with the same base, add the exponents.	$2^2 \cdot 2^4$ $= (2)(2) \cdot (2)(2)(2)(2)$ $= 2^6$ $(-4)^8(-4)^5 \quad 3^9 \cdot 3^4 \cdot 3$
The Quotient Law	When dividing powers with the same base, subtract the exponents.	$3^4 \div 3^2$ $= \frac{3 \cdot 3 \cdot 3 \cdot 3}{3 \cdot 3}$ $= 3^2$ $(-7)^{18} \div (-7)^{11} \quad \frac{2^5}{2^3}$

Power of a Power

When a power is raised to an exponent, multiply the exponents.

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

$$[(-3)^{12}]^2 \quad (2^5)^4$$

Power of a Product Law

An exponent must be applied to each coefficient and variable of a product.

$$(2a^4)^3$$

$$(x^3y^4z)^2$$

Power of a Quotient Law

An exponent must be applied to each coefficient and variable of a quotient.

$$\left(\frac{3x}{4y^2}\right)^2$$

Complete the following tables of values.

x	y=2 ^x
4	
3	
2	
1	
0	
-1	
-2	
-3	
-4	

x	y=3 ^x
4	
3	
2	
1	
0	
-1	
-2	
-3	
-4	

The Zero Exponent Law

All powers with an exponent of zero are equal to one.

Negative Exponents

All powers with negative exponents are equal to the reciprocal of the base raised to the equal positive exponent.

a) $\left(\frac{1}{2}\right)^{-2}$

b) $\left(\frac{3}{4}\right)^{-3}$

c) $(25)^{-1}$

Examples – Simplify the following expressions using the power laws. Write all final answers with positive exponents. Evaluate if possible.

a) $x^3 \cdot x^{-8}$

b) $(5xy^2)^3$

c) $\frac{y^7}{y^{-2}}$

d) $\left(\frac{123}{456789}\right)^0$

e) $(4xy^2z^3)^{-2}$

f) $\frac{1}{x^{-5}}$

g) $z^{13} \cdot z^{-10} \cdot z^0$

h) $(-5)^{-30} \div (-5)^{-28}$

i) $2^0 + 3^0$

j) -18^0

k) $(a^3)^{-2}$

l) $4^{-2} - 2^{-3}$

m) $\frac{5^{-4}}{2^{-3}}$