

The background of the slide features a pattern of stylized autumn leaves in various shades of orange and brown, set against a darker orange gradient background. The leaves are scattered across the frame, with some showing detailed vein structures.

# Exponent Rules

# Parts

- When a number, variable, or expression is raised to a power, the number, variable, or expression is called the **base** and the power is called the **exponent**.



The diagram shows the mathematical expression  $b^n$  in a large, white, serif font. Two arrows originate from the text above: a blue arrow points from the word "base" to the letter  $b$ , and a red arrow points from the word "exponent" to the letter  $n$ .

$$b^n$$

# What is an Exponent?

- An exponent means that you multiply the base by itself that many times.
- For example

$$x^4 = x \cdot x \cdot x \cdot x$$

$$2^6 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 = 64$$

# The Invisible Exponent

- When an expression does not have a visible exponent its exponent is understood to be 1.

$$x = x^1$$

# Exponent Rule #1

- When **multiplying** two expressions with the same base you **add** their exponents.

$$b^n \cdot b^m = b^{n+m}$$

- For example

$$x^2 \cdot x^4 = x^{2+4} = x^6$$

$$2 \cdot 2^2 = 2^1 \cdot 2^2 = 2^{1+2} = 2^3 = 8$$

# Exponent Rule #1

$$b^n \cdot b^m = b^{n+m}$$

■ Try it on your own:

$$1. h^3 \cdot h^7 = h^{3+7} = h^{10}$$

$$2. 3^2 \cdot 3 = 3^{2+1} = 3^3 \\ = 3 \cdot 3 \cdot 3 = 27$$

# Exponent Rule #2

- When **dividing** two expressions with the same base you **subtract** their exponents.

$$\frac{b^n}{b^m} = b^{n-m}$$

- For example

$$\frac{x^4}{x^2} = x^{4-2} = x^2$$

# Exponent Rule #2

$$\frac{b^n}{b^m} = b^{n-m}$$

■ Try it on your own:

$$3. \frac{h^6}{h^2} = h^{6-2} = h^4$$

$$4. \frac{3^3}{3} = 3^{3-1} = 3^2 = 9$$



# Exponent Rule #3

- When raising a **power to a power** you **multiply** the exponents

$$(b^n)^m = b^{n \cdot m}$$

- For example

$$(x^2)^4 = x^{2 \cdot 4} = x^8$$

$$(2^2)^2 = 2^{2 \cdot 2} = 2^4 = 16$$

## Exponent Rule #3

$$(b^n)^m = b^{n \cdot m}$$

- Try it on your own

$$5. (h^3)^2 = h^{3 \cdot 2} = h^6$$

$$6. (3^2)^2 = 3^{2 \cdot 2} = 3^4 = 81$$

# Note

- When using this rule the exponent can not be brought in the parenthesis **if there is addition or subtraction**

$$(x^2 + 2^2)^2 \neq x^4 + 2^4$$

You would have to use FOIL in these cases

# Exponent Rule #4

- When a product is raised to a power, each piece is raised to the power

$$(ab)^m = a^m b^m$$

- For example

$$(xy)^2 = x^2 y^2$$

$$(2 \cdot 5)^2 = 2^2 \cdot 5^2 = 4 \cdot 25 = 100$$

## Exponent Rule #4

$$(ab)^m = a^m b^m$$

■ Try it on your own

$$7. (hk)^3 = h^3 k^3$$

$$8. (2 \cdot 3)^2 = 2^2 \cdot 3^2 = 4 \cdot 9 = 36$$

# Note

- This rule is for products only. When using this rule the exponent can not be brought in the parenthesis **if there is addition or subtraction**

$$(x + 2)^2 \neq x^2 + 2^2$$

You would have to use FOIL in these cases

# Exponent Rule #5

- When a quotient is raised to a power, both the numerator and denominator are raised to the

power

$$\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}$$

- For example

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

# Exponent Rule #5

$$\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}$$

■ Try it on your own

$$9. \left(\frac{h}{k}\right)^2 = \frac{h^2}{k^2}$$

$$10. \left(\frac{4}{2}\right)^2 = \frac{4^2}{2^2} = \frac{16}{4} = 4$$



# Zero Exponent

- When anything, except 0, is raised to the zero power it is 1.

$$a^0 = 1 \quad (\text{if } a \neq 0)$$

- For example

$$x^0 = 1 \quad (\text{if } x \neq 0)$$

$$25^0 = 1$$

# Zero Exponent

$$a^0 = 1 \quad (\text{if } a \neq 0)$$

■ Try it on your own

$$11. \quad h^0 = 1 \quad (\text{if } h \neq 0)$$

$$12. \quad 1000^0 = 1$$

$$13. \quad 0^0 = 0$$

# Negative Exponents

■ If  $b \neq 0$ , then 
$$b^{-n} = \frac{1}{b^n}$$

■ For example

$$x^{-2} = \frac{1}{x^2}$$

$$3^{-2} = \frac{1}{3^2} = \frac{1}{9}$$

# Negative Exponents

■ If  $b \neq 0$ , then  $b^{-n} = \frac{1}{b^n}$

■ Try it on your own:

$$14. h^{-3} = \frac{1}{h^3}$$

$$15. 2^{-3} = \frac{1}{2^3} = \frac{1}{8}$$

# Negative Exponents

- The negative exponent basically flips the part with the negative exponent to the other half of the fraction.

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

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

# Math Manners

- For a problem to be completely simplified there should not be any negative exponents

## Mixed Practice

$$1. \frac{6d^5}{3d^9} = 2d^{5-9} = 2d^{-4} = \frac{2}{d^4}$$

$$2. 2e^4 4e^5 = 8e^{4+5} = 8e^9$$

## Mixed Practice

$$3. (q^4)^5 = q^{4 \cdot 5} = q^{20}$$

$$4. (2lp)^5 = 2^5 l^5 p^5 = 32l^5 p^5$$



## Mixed Practice

$$5. \frac{(x^2 y)^4}{(xy)^2} = \frac{x^8 y^4}{x^2 y^2} = x^{8-2} y^{4-2} = x^6 y^2$$


$$6. \frac{(x^3 x^5)^2}{x^9} = \frac{(x^8)^2}{x^9} = \frac{x^{16}}{x^9} = x^{16-9} = x^7$$

# Mixed Practice

$$\begin{aligned} 7. & (m^6 n^4)^2 (m^3 n^2 p^5)^6 \\ &= m^{12} n^8 \cdot m^{18} n^{12} p^{30} \\ &= m^{12+18} n^{8+12} p^{30} \\ &= m^{30} n^{20} p^{30} \end{aligned}$$

# Mixed Practice

$$8. \frac{(x-2y)^6}{(x-2y)^4} = (x-2y)^{6-4} = (x-2y)^2$$

$$= (x-2y)(x-2y)$$
A diagram illustrating the FOIL method for expanding the product of two binomials, (x-2y)(x-2y). White arrows point from the first 'x' in the first binomial to the first 'x' in the second binomial. Another white arrow points from the first 'x' in the first binomial to the second '-2y' in the second binomial. A third white arrow points from the second '-2y' in the first binomial to the first 'x' in the second binomial. A fourth white arrow points from the second '-2y' in the first binomial to the second '-2y' in the second binomial.

$$= x^2 \overset{F}{-} 2xy \overset{O}{-} 2xy \overset{L}{+} 4y^2$$

$$= x^2 - 4xy + 4y^2$$

# Mixed Practice

$$9. \frac{a^6 d^5}{a^4 d^9} = a^{6-4} d^{5-9} = a^2 d^{-4}$$

$$= \frac{a^2}{d^4}$$