Pre-Algebra

Essential Question: How can the laws (properties) of exponents help us simplify and evaluate exponential expressions?

Do Now: Evaluate each **exponential** expression.

a) 5^2 $5 \cdot 5 = 25$ b) 2^4 $2 \cdot 2 \cdot 2 \cdot 2 = 16$

c) $(-3)^3$ $(-3)(-3)(-3) = -27$ d) $(-1)^{10}$ 1

even exponent → ⊕
odd exponent → ⊖
* 1 raised to any power = 1

Exponents

An exponent is a mathematical notation that implies the number of times a specific number is used as a factor in a multiplication expression.

Powers represent repeated multiplication of the same factor.

Example: (-15)(-15)(-15) *can be expressed as* $(-15)^3$

factor/base → $(-15)^3$ ← exponent

Power	Base	Exponent	Evaluate
7^2	7	2	$7 \cdot 7 = 49$
$(-4)^3$	-4	3	$(-4)(-4)(-4) = -64$
-6^2	6	2	$-(6 \cdot 6) = -36$

"the opposite of"

Zero Power

of zeros

$2^4 =$ 16 ÷2 $10^4 =$ 10000

$2^3 =$ 8 ÷2 $10^3 =$ 1000

$2^2 =$ 4 ÷2 $10^2 =$ 100

$2^1 =$ 2 ÷2 $10^1 =$ 10

$2^0 =$ 1 $10^0 =$ 1

Look for a pattern.

Can we write a rule about the power of zero?

Rule (Law) #1: $a^0 = 1, \ a \neq 0$

Any non-zero number raised to the zero power equals one.

Evaluate (x *represents a nonzero number*).

1. $87^0 =$ 1
2. $x^0 =$ 1
3. $(3x)^0 =$ 1
4. $3x^0 =$ $3 \cdot 1 = 3$

Negative Exponents

Powers of 2	Powers of 10
$2^4 = 2 \times 2 \times 2 \times 2 = \mathbf{16}$	$10^4 = 10 \times 10 \times 10 \times 10 = \mathbf{10{,}000}$
$2^3 = 2 \times 2 \times 2 = \mathbf{8}$	$10^3 = 10 \times 10 \times 10 = \mathbf{1{,}000}$
$2^2 = 2 \times 2 = \mathbf{4}$	$10^2 = 10 \times 10 = \mathbf{100}$
$2^1 = \mathbf{2}$	$10^1 = \mathbf{10}$
$2^0 = \mathbf{1}$	$10^0 = \mathbf{1}$
$2^{-1} = \frac{1}{2} = \frac{1}{2^1}$	$10^{-1} = \frac{1}{10} = \frac{1}{10^1}$
$2^{-2} = \frac{1}{4} = \frac{1}{2^2}$	$10^{-2} = \frac{1}{100} = \frac{1}{10^2}$
$2^{-3} = \frac{1}{8} = \frac{1}{2^3}$	$10^{-3} = \frac{1}{1000} = \frac{1}{10^3}$

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Rule (Law) #2:

$a^{-n} = \frac{1}{a^n}$

1) Take the reciprocal (flip) of the base, and
2) Change the exponent from a negative to a positive.

Rewrite each expression using only positive exponents (*all variables represent nonzero numbers*).

5. 7^{-5}

$\frac{1}{7^5}$

6. 9^{-10}

$\frac{1}{9^{10}}$

7. $(-11)^{-8}$

$\frac{1}{(-11)^8}$

8. a^{-7}

$\frac{1}{a^7}$

9. $(3a)^{-7}$

$\frac{1}{(3a)^7}$

10. $3a^{-7}$

$\frac{3}{1} \cdot \frac{1}{a^7} = \frac{3}{a^7}$

Evaluate each of the following expressions (*all variables represent nonzero numbers*).

11. 3^{-2}

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

12. 5^{-3}

$\frac{1}{5^3} = \frac{1}{125}$

13. $(-2)^{-5}$

$\frac{1}{(-2)^5} = \frac{1}{-32}$

$(-2)(-2)(-2)(-2)(-2) = -32$

14. $(-1)^{-4}$

$\frac{1}{(-1)^4} = \frac{1}{1} \rightarrow 1$

$(-1)(-1)(-1)(-1) = 1$

15. x^{-6}

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

16. $m^0 n^{-7}$

$\frac{1}{1} \cdot \frac{1}{n^7} = \frac{1}{n^7}$

The TAKE AWAY

We learned two rules (laws) that help us simplify and evaluate exponential expressions.

Law #1: Any nonzero number raised to the zero power is always equal to 1.

Law #2: $a^{-n} = \frac{1}{a^n}$ and $a \neq 0$.

TURN and TALK

Order the following numbers from least to greatest.

4^2	4^{-2}	4^0	-4^2
16	$\frac{1}{16}$	1	-16

$-4^2, 4^{-2}, 4^0, 4^2$