Zero & Negative Exponents

Complete the following chart. Evaluate each to standard form. Leave as whole numbers or fractions.

Expression to be Simplified	Write in Expanded Form	Using Exponent Laws
$\frac{2^3}{2^1}$	$=\frac{2\times2\times2}{2}$ $=4$	$2^{3-1}=2^2$ $=4$
$\frac{2^3}{2^2}$	$=\frac{\not{2}\times\not{2}\times2}{\not{2}\times\not{2}}=\frac{4}{2}=2$	$2^{3-2}=2^1$ $=2$
$\frac{2^3}{2^3}$	$=\frac{\not{2}\times\not{2}\times\not{2}}{\not{2}\times\not{2}\times\not{2}}=1$	$2^{3-3}=2^0$ $=1$
$\frac{2^3}{2^4}$	$=\frac{\not{2}\times\not{2}\times\not{2}}{\not{2}\times\not{2}\times\not{2}\times2}=\frac{1}{2}$	$2^{3-4}=2^{-1}$ $=\frac{1}{2}$
$\frac{2^3}{2^5}$	$=\frac{\not{2}\times\not{2}\times\not{2}}{\not{2}\times\not{2}\times\not{2}\times2\times2}=\frac{1}{2\times2}=\frac{1}{4}$	$2^{3-5}=2^{-2}$ $=\frac{1}{2^2}=\frac{1}{4}$

HOW is the exponent law expression **RELATED TO** the expanded form expression?

They are the same

What do you notice about the result of an expression with an **exponent of zero**?

They are equal to one

What do you notice about the result of an expression with an **exponent that is negative**?

The term becomes a fraction $\frac{1}{base}$ **with an exponent on the base that is positive**

THE ZERO EXPONENT

Any number (or expression) divided by itself is equal to **one**

Use exponent laws to evaluate each of the following:

a) $\frac{2^3}{2^3}=2^{3-3}=2^0=1$

b) $\frac{3^2}{3^2}=3^{2-2}=3^0=1$

c) $\frac{x^4}{x^4}=x^{4-4}=x^0=1$

Therefore, for zero exponents: Any **BASE** raised to an **exponent of zero** is equal to **one**

$$a^0 = 1$$

EXAMPLES

Evaluate.

$7^0=1$

$x^0=1$

$3\times2^0=3\times1=3$

$x^0y=1\times y=y$

THE NEGATIVE EXPONENT

Any BASE raised to a NEGATIVE exponent is equal to the ___RECIPROCAL___ of the base raised to the same ___positive___ exponent.

$$a^{-m} = \frac{1}{a^m} \quad \text{and} \quad \frac{1}{a^{-m}} = a^m$$

Use exponent laws to simplify each of the following. Then evaluate to standard form.

a) $\frac{2^3}{2^4} = 2^{3-4} = 2^{-1} = \frac{1}{2}$

b) $\frac{3^2}{3^5} = 3^{2-5} = 3^{-3} = \frac{1}{3^3} = \frac{1}{27}$

c) $\frac{4^5}{4^7} = 4^{3-4} = 4^{-1} = \frac{1}{4^2} = \frac{1}{16}$

EXAMPLES

Simplify and evaluate.

$7^{-1} = \frac{1}{7}$ $\quad (-8)^{-2} = \frac{1}{8^2} = \frac{1}{64}$ $\quad 2^{-3} = \frac{1}{2^3} = \frac{1}{8}$ $\quad (-3)^{-3} = \frac{1}{(-3)^3} = -\frac{1}{27}$

EXERCISE: Complete the following table.

Exponent Form	3^2	5^{-1}	10^0	3^{-3}	3^{-1}	2^{-n}	3^{-m}	$(-1225)^0$
Simplified Form	9	$\frac{1}{5}$	1	$\frac{1}{3^3} = \frac{1}{27}$	$\frac{1}{3}$	$\frac{1}{2^n}$	$\frac{1}{5^m}$	1

SIMPLIFYING EXPRESSIONS

The rules for positive exponents also work for zero and negative exponents. Continue to follow the rules for order of operations (BEDMAS) when simplifying & evaluating.

EXAMPLES

Simplify and evaluate each of the following:

$$3^3 \times 3^{-5} = 3^{3+(-5)} = 3^{3-5} = 3^{-2} = \frac{1}{3^2} = \frac{1}{9}$$

$$\frac{(-2)^2}{(-2)^{-3}} = (-2)^{2-(-3)} = (-2)^{2+3} = (-2)^5 = -32$$

$$\left(\frac{3^2}{3^4}\right)^2 = \left(3^{2-4}\right)^2 = \left(3^{-2}\right)^2 = 3^{-4} = \frac{1}{3^4} = \frac{1}{81}$$