Negative Exponents

What are you noticing?

$10^{-2} = \frac{1}{10^2} = \frac{1}{100}$

Table 1	
Exponential Form	Standard Form
10^5	100,000
10^4	10,000
10^3	1,000
10^2	100
10^1	10
10^0	1
10^{-1}	$\frac{1}{10}$
10^{-2}	$\frac{1}{100}$
10^{-3}	$\frac{1}{1000}$

What rule can we write?

$4^{-2} = \frac{1}{4^2}$

$100^{-3} = \frac{1}{100^3}$

$-50^{-5} = -\frac{1}{50^5}$

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

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Warm-Up

Using the numbers 0-9, at most once, create an expression closest to zero as possible

$$\square^{\square} - \square = \frac{\square}{\square\square}$$

The Product Rule - What do you think happens?

Similar bases; you multiply, you ADD exponents.

$2^3 \cdot 2^5 = (2\cdot2\cdot2)(2\cdot2\cdot2\cdot2\cdot2)$

$2^8 = 2^{3+5}$

$2^4 \cdot 3^6$ } unlike bases

$x^4 \cdot y^6$

Why?

$2^3 \cdot 2^5 = \underbrace{2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2}_{8 \text{ factors of } 2} = 2^8$

$x^2 \cdot x^3 = \underbrace{x \cdot x \cdot x \cdot x \cdot x}_{5 \text{ of them}} = x^5$

The Rule

Product Rule:

For any real base b,
$b^n \cdot b^m = b^{n+m}$

$x^9 \cdot x^6 = x^{9+6}$

More Examples with integer bases

$2^1 \cdot 2^2 \cdot 2^2$

$2+1+2=5$

2^5

$(2)(2)(2)(2)(3)$

$4^3 \cdot 4^2$

$(4 \cdot 4 \cdot 4)(4 \cdot 4)$

4^5

$x^8 \bullet x^5$

$8+5=13$

x^{13}

$x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x$

Talk with your partner...
What happens when there's coefficients?

$3(x \cdot x \cdot x) \cdot 4(x \cdot x)$

$12x^5$

$3x^3 \bullet 4x^2$

$(3x)^3 \cdot (4x)^2$

$(3x \cdot 3x \cdot 3x) \cdot (4x \cdot 4x)$

-3^0

$(-3)^0$

Choose 1 Challenge Problem!

$2a^4 \cdot 4a^2b^4$

$a^3b^3 \cdot 4a^3b^4$

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Quotient Rule - Investigation with Partner

Why?

Expression	Expanded Form	Equivalent Expression in Exponential Form
$\frac{2^8}{2^5}$	$\frac{2\cdot2\cdot2\cdot2\cdot2\cdot2\cdot2\cdot2}{2\cdot2\cdot2\cdot2\cdot2}$	$2^{8-5}=2^3$
$\frac{2^2}{2^6}$	$\frac{2\cdot2}{2\cdot2\cdot2\cdot2\cdot2\cdot2}=\frac{1}{2^4}$	$2^{2-6}=2^{-4}$

$\frac{3^3}{3^6}=\frac{3\cdot3\cdot3}{3\cdot3\cdot3\cdot3\cdot3\cdot3}$

$\frac{1}{3^3}$

The Rule

Quotient Rule:

For any real base $b \neq 0$,

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

Let's Practice

$\frac{8^5}{8^2}$ $\frac{c}{c^5}$ $\frac{3^5}{3^7}$ $\frac{12x^5}{4x^2}$