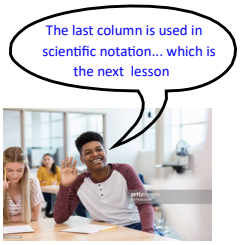
1.9 Negative and Zero Exponents

Time to investigate

Use patterns to evaluate powers. No decimals (leave as a fraction).
Complete the statements below and then describe the pattern.

$2^4 = 16$ ÷2	$3^4 = 81$ ÷3	$10^4 = 10\,000$ ÷10
$2^3 = 8$ ÷2	$3^3 = 27$ ÷3	$10^3 = 1000$ ÷10
$2^2 = 4$ ÷2	$3^2 = 9$ ÷3	$10^2 = 100$
$2^1 = 2$	$3^1 = 3$	$10^1 = 10$
$2^0 = 1$	$3^0 = 1$	$10^0 = 1$
$2^{-1} = \frac{1}{2}$	$3^{-1} = \frac{1}{3}$	$10^{-1} = \frac{1}{10}$
$2^{-2} = \frac{1}{4}$	$3^{-2} = \frac{1}{9}$	$10^{-2} = \frac{1}{100}$
$2^{-3} = \frac{1}{8}$	$3^{-3} = \frac{1}{27}$	$10^{-3} = \frac{1}{1000}$



Do you see a pattern?

Dividing by the base each time

What do you notice about 2^1, 3^1, 10^1?

Means only raised to itself. ex $2^1 = 2$
Always equal to the base.

What do you notice about 2^0, 3^0, 10^0?

$= 1$

Conclusion:
Any base raised to the exponent 1 is the base.
Any base raised to the exponent 0 is 1.

Let's take a look at the negative exponents.

What do you notice about 2^{-1}, 3^{-1}, 10^{-1} ?

$= \frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{10}$

What do you notice about 2^{-3} and 2^3, 3^{-2} and 3^2 ?

$2^{-3} = \frac{1}{8}$ $\quad 2^3 = 8$ $\quad 3^{-2} = \frac{1}{9}$ $\quad 3^2 = 9$

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

Reflect

Explain how to evaluate a power with a negative exponent.

One over the base to the positive exponent

ex $6^{-3} = \frac{1}{6^3}$

$= \frac{1}{216}$

Summary

Any base raised to a negative exponent is equal to the reciprocal **of the base raised to a** positive exponent **.**

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

Let's 

Don't forget:
Anything raised to a zero is 1
$a^0 = 1$

Ex. 1 Write as a power with a positive exponent and then evaluate (No decimals- leave as a fraction)

a) 4^{-2}
$= \frac{1}{4^2}$
$= \frac{1}{16}$

b) $(1234567)^0$
$= 1$

c) 5^{-3}
$= \frac{1}{5^3}$
$= \frac{1}{125}$

d) $3^{-7} \times 3^5$
$= 3^{-7+5}$
$= 3^{-2}$
$= \frac{1}{3^2}$
$= \frac{1}{9}$

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

f) $(3^{-2})^{-4}$
$= 3^{-2 \times -4}$
$= 3^8$
$= 6561$

g) $10^{-5} \div 10^{-3}$
$= 10^{-5-(-3)}$
$= 10^{-2}$
$= \frac{1}{10^2}$
$= \frac{1}{100}$

Ex. 2 Evaluate and explain how the powers are different

a) -2^4
$= -2^4$
$= -16$

b) 2^{-4}
$= \frac{1}{2^4}$
$= \frac{1}{16}$

c) $(-2)^{-4}$
$= \frac{1}{(-2)^4}$
$= \frac{1}{16}$

d) $(-2)^4$
$= 16$