Warm Up:
Evaluate. (yes you can use a calculator)

\[
\begin{align*}
5^2 &= 25, \\
4^2 &= 16, \\
6^2 &= 36
\end{align*}
\]

\[
\begin{align*}
3^5 &= 243, \\
7^3 &= 343, \\
2^4 &= 16
\end{align*}
\]

\[
\begin{align*}
10^1 &= 10, \\
100^1 &= 100, \\
1^{100} &= 1
\end{align*}
\]

Learning Goal: I will be able to simplify expressions involving zero and negative exponents.

Vocabulary:
Exponents Review:

\[x^5 = x \cdot x \cdot x \cdot x \cdot x\]

Zero exponent:

Any nonzero number \( x \), \( x^0 = 1 \)

Examples 1-3:
Simplify

\[
\begin{align*}
4^0 &= 1, \\
(-3)^0 &= 1, \\
(5.14)^0 &= 1
\end{align*}
\]
Examples 4-7: (with your shoulder buddy)
Simplify
\[3^0 = 1 \quad 2^0 = 1 \quad 0^0 = \text{undefined} \quad 1^0 = 1\]

Examples 8-11:
Why can’t you use 0 as a base with zero exponents?
\[0^3 = 0 \quad 0^2 = 0 \quad 0^1 = 0 \quad 0^0 = \text{undefined}\]

It is not possible for \(0^0\) to equal both 1 and 0. Therefore \(0^0\) is undefined!!

Vocabulary:

Negative Exponent
For every nonzero number \(a\) and integer \(n\),
\[\frac{a^{-n}}{1} = \frac{1}{a^n} \quad \text{and} \quad \frac{1}{a^{-n}} = a^n\]

Examples 12 and 13:
Simplify
\[\frac{7^{-3}}{1} = \frac{1}{343} \quad \frac{(-5)^2}{1} = \frac{1}{(-5)^2} \cdot \frac{1}{25}\]
Examples 14-16:
Simplify the expression.
\[
\frac{9^2}{1} = \frac{1}{q^2} \cdot \frac{1}{81} \cdot 4^3 = \frac{1}{4^3} = \frac{1}{64} \cdot \frac{3^2}{1} = \frac{1}{9}
\]

Examples 17-19:
Simplify the expression.
\[
\frac{5a^3b^2}{x^5} = \frac{\sqrt[5]{x^5}}{1} \quad \frac{1}{46^3b} = \frac{\sqrt[3]{b}}{1}
\]

Examples 20-23:
(shoulder buddy)
Simplify each expression.
\[
x^{-9} = \frac{1}{x^9} \quad \frac{2}{a^{-3}} = \frac{2a^3}{1}
\]
\[
\frac{1}{n^3} = n^{-3} \quad \frac{n^{-5}}{m^2} = \frac{1}{n^5m^2}
\]

Examples 24-26:
Evaluate each expression for \( r = -3 \) and \( s = 5 \).
\[
\frac{r^3}{s^2} = \frac{(-3)^3}{5^2} \quad 3(-3)(5)^2 = \frac{(-3)^3}{27} \quad (-3)^4 = \frac{5^2}{81}
\]
A population of marine bacteria doubles every hour under controlled laboratory conditions. The number of bacteria is modeled by the expression $1000 \cdot 2^h$, where $h$ is the number of hours after a scientist measures the population size. Evaluate the expression for $h = 0$, $h = -3$. What does each value of the expression represent in the situation?

\[
\frac{1000 \cdot 2^0}{1000 \cdot 1} = \frac{1000}{1000} = 1 \text{ bacteria at the beginning}
\]

\[
\frac{1000}{8} = 125 \text{ bacteria 8 hours before start}
\]

**Summary**

How do you make a negative exponent positive? Move to opposite side of fraction.

Anything (except zero) to the zero power is **one**!!!