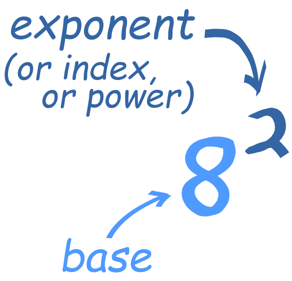
Exponents

The **exponent** of a number says **how many times** to use the number in a multiplication.



In **8^2** the "2" says to use 8 twice in a multiplication,
so **$8^2 = 8 \times 8 = 64$**

In words: 8^2 could be called "8 to the power 2" or "8 to the second power", or simply "8 squared"

Exponents are also called Powers or Indices.

Some more examples:

Example: **$5^3 = 5 \times 5 \times 5 = 125$**

- In words: 5^3 could be called "5 to the third power", "5 to the power 3" or simply "5 cubed"

Example: **$2^4 = 2 \times 2 \times 2 \times 2 = 16$**

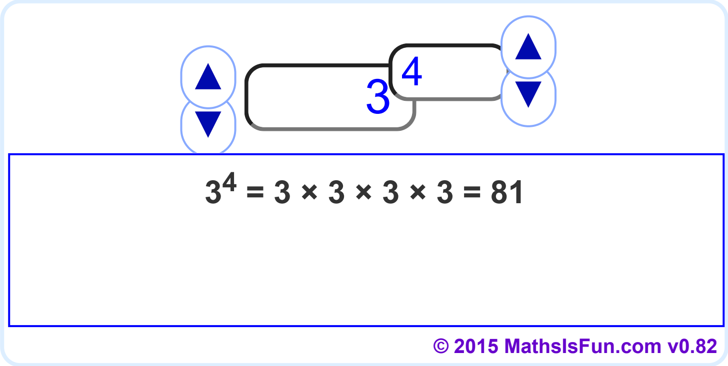
- In words: 2^4 could be called "2 to the fourth power" or "2 to the power 4" or simply "2 to the 4th"

Exponents make it easier to write and use many multiplications

Example: **9^6** is easier to write and read than **$9 \times 9 \times 9 \times 9 \times 9 \times 9$**

You can multiply **any** number by itself **as many times** as you want using exponents.

Try here:



In General

So **in general**:

a^n tells you to multiply **a** by itself, so there are **n** of those **a**'s:

$$a^n = \underbrace{a \times a \times \ldots \times a}_{n}$$

Another Way of Writing It

Sometimes people use the **^** symbol (above the 6 on your keyboard), as it is easy to type.

Example: **2^4 is the same as 2^4**

- **2^4 = 2 × 2 × 2 × 2 = 16**

Negative Exponents

Negative? What could be the opposite of multiplying?

Dividing!

A negative exponent means how many times **to divide** one by the number.

Example: **$8^{-1} = 1 \div 8 = 0.125$**

You can have many divides:

Example: $5^{-3} = 1 \div 5 \div 5 \div 5 = 0.008$

But that can be done an easier way:

5^{-3} could also be calculated like:

$$1 \div (5 \times 5 \times 5) = 1/5^3 = 1/125 = 0.008$$

Negative? Flip the Positive!

That last example showed an easier way to handle negative exponents:

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

- Calculate the positive exponent (a^n)
- Then take the Reciprocal (i.e. $1/a^n$)

More Examples:

Negative Exponent		Reciprocal of Positive Exponent		Answer
4^{-2}	=	$1 / 4^2$	=	$1/16 = 0.0625$
10^{-3}	=	$1 / 10^3$	=	$1/1,000 = 0.001$
$(-2)^{-3}$	=	$1 / (-2)^3$	=	$1/(-8) = -0.125$

What if the Exponent is 1, or 0?

1 If the exponent is 1, then you just have the number itself (example $\mathbf{9^1} = \mathbf{9}$)

0 If the exponent is 0, then you get **1** (example $\mathbf{9^0} = \mathbf{1}$)

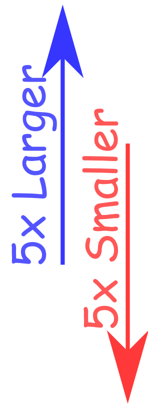
But what about $\mathbf{0^0}$? It could be either 1 or 0, and so people say it is *"indeterminate"*.

It All Makes Sense

My favorite method is to start with "1" and then multiply or divide as many times as the exponent says, then you will get the right answer, for example:

Example: Powers of 5

	.. etc..	
$\mathbf{5^2}$	**1 × 5 × 5**	25
$\mathbf{5^1}$	**1 × 5**	5
$\mathbf{5^0}$	**1**	1
$\mathbf{5^{-1}}$	**1 ÷ 5**	0.2
$\mathbf{5^{-2}}$	**1 ÷ 5 ÷ 5**	0.04
	.. etc..	



If you look at that table, you will see that positive, zero or negative exponents are really part of the same (fairly simple) pattern.

Be Careful About Grouping

To avoid confusion, use parentheses ( ) in cases like this:

With () : $\mathbf{(-2)^2} = (-2) \times (-2) = \mathbf{4}$

Without () : $\mathbf{-2^2} = -(2^2) = -\ (2 \times 2) = \mathbf{-4}$

With () : $\mathbf{(ab)^2} = \mathbf{ab \times ab}$

Without () : $\mathbf{ab^2} = a \times (b)^2 = \mathbf{a \times b \times b}$

Question 1 Question 2 Question 3 Question 4 Question 5
Question 6 Question 7 Question 8 Question 9 Question 10