Exponents 2

Let's calculate 2^4, then 2^3, then 2^2, and so on.

$2^4 = 2x2x2x2$, *and 2x2=4, so* $= 4x2x2$, *and 4x2=8, so* $= 8x2$, *and 8x2=16, so* $= 16$	$2^3 = 2x2x2$, *2x2=4, so* $= 4x2$, *and 4x2=8, so* $= 8$	$2^2 = 2x2$, *2x2=4, so* $= 4$

The difference between each of these numbers is a single step, a single x2. To raise the exponent by 1, we must multiply by two -- so to ***lower*** the exponent by 1, we must divide by two.

$2^4 = 16$ $\Uparrow$	$2^3 = 2^4 \div 2$ $2^3 = 16 \div 2$ $2^3 = 8$	$2^2 = 2^3 \div 2$ $2^2 = 8 \div 2$ $2^2 = 4$

This method is giving us the same answers as we were getting before. Let's keep going.

$2^1 = 2^2 \div 2$ $2^1 = 4 \div 2$ $2^1 = 2$	$2^0 = 2^1 \div 2$ $2^0 = 2 \div 2$ $2^0 = 1$	$2^{-1} = 2^0 \div 2$ $2^{-1} = 1 \div 2$ $2^{-1} = \frac{1}{2}$	$2^{-2} = 2^{-1} \div 2$ $2^{-2} = \frac{1}{2} \div 2$ $2^{-2} = \frac{1}{2x2}$ $2^{-2} = \frac{1}{2^2}$	$2^{-3} = 2^{-2} \div 2$ $2^{-3} = \frac{1}{2x2} \div 2$ $2^{-3} = \frac{1}{2x2x2}$ $2^{-3} = \frac{1}{2^3}$

The same pattern works for any number except zero. This is why a number to the first power (x^1) is always equal to that number. This is why a number to the zeroth power (x^0) is always equal to one. Any number to a *negative power* is equal to one divided by the positive version of that power. To say that in a mathy way, we could write that, for any number "a" (except zero), and any number b:

$a^1 = a$	$a^0 = 1$	$a^b = a^{b-1}\ x\ b$	$a^b \div a = a^{b-1}$	$a^{-b} = \frac{1}{a^b}$

You can raise negative numbers to powers too.

$(-2)^2 = (-2)x(-2)$ $(-2)^2 = +4$ $+(2^2) = +4$	$(-2)^3 = (-2)x(-2)x(-2)$ $(-2)^3 = +4\ x\ (-2)$ $(-2)^3 = -8$ $-(2^3) = -8$	$(-2)^4 = (-2)x(-2)x(-2)x(-2)$ $(-2)^4 = +4\ x\ (-2)x(-2)$ $(-2)^4 = -8\ x\ (-2)$ $(-2)^4 = +16$ $+(2^4) = +16$

Any time the exponent is ***even***, your result will be positive because every negative sign will be able to cancel itself out against another negative sign. Any time the exponent is ***odd***, your result will be negative, because there will be one negative sign left over.