Indices Laws

Before You Watch

This video deals with numbers called indices, specifically as applied to algebra. We often call them powers, or exponents. An example is the number 3^5, which we read as "three to the power of five". This means three times itself five times:

$3^5 = 3 \times 3 \times 3 \times 3 \times 3$

Here the number 5 is called the exponent or the index. The plural of index is indices. This definition of indices, or exponents, is well demonstrated here:

- http://www.mathsisfun.com/algebra/exponent-laws.html

This topic builds on the fundamental concepts of algebra covered in **Introduction to Algebra**. If you need a refresher on algebra in general, watch that video first, then come back.

The Video Content

This topic covers some of the basic laws of indices, and looks at how they apply to algebra.

To refresh our memories about indices we'll start with the example 4^3. We refer to the number 3 as an index. We know that this means 4 multiplied by itself 3 times:

$4^3 = 4 \times 4 \times 4$

It's the same for algebra:

$b^3 = b \times b \times b$

What happens when we multiply these terms together?

Consider:

k^3 x k^2

This means k multiplied by itself 3 times, then multiplied by k another two times. So it's equal to k to the power of five:

k^3 x k^2 = k^5

If we multiply, using the same letter, we can just add the powers.

Another example:

a^4 x a^3 = $a^{(4+3)}$

a^4 x a^3 = a^7

What about division?

Let's say, for example:

f^4 / f^2

That's f multiplied 4 times, divided by f multiplied twice. We can simplify this fraction by crossing off two f's from both the top and bottom. That leaves us with f multiplied twice, in other words f squared:

f^4 / f^2 = f^2

As we can see from this, what really happened is that we subtracted the indices!

Another example:

a^{13} / a^5 = $a^{(13-5)}$

a^{13} / a^5 = a^8

What about when the equation has more than one letter in it? Say:

n^3m^5 x n^4m^2 / n^2m^3

As is the case for only one letter, we add the indices when multiplying and subtract the indices when dividing – but this time it's done separately for each letter. So, the above example is equal to:

$n^{(3+4-2)}m^{(5+2-3)}$ = n^5m^4

Finally, let's look at expressions like:

$(r^3)^2$

Just as with numbers, we do the part inside the brackets first:

$(r^3)^2 = (r \times r \times r)^2$

and then multiply as many times as the index indicates: in this case, twice.

So this is equal to:

$(r \times r \times r)^2 = (r \times r \times r) \times (r \times r \times r)$

which is r multiplied 6 times:

$(r \times r \times r) \times (r \times r \times r) = r \times r \times r \times r \times r \times r$

which is r to the power of 6:

$r \times r \times r \times r \times r \times r = r^6$

In other words, the powers are multiplied. So:

$(y^5)^{11}$

is simply:

$(y^5)^{11} = y^{(5 \times 11)} = y^{55}$

Some Practice Questions

1. $3k^8 \times 2k^4 =$
2. $10y^{11} / 5y^3 =$
3. $b^2j^7 \times j^5m^3 =$
4. $r^8 \times r^3 / r^2 =$
5. $(p^4)^3 \times p^9 =$
6. $(w^7)^2 / (w^3)^3 =$
7. $q^6t^5f^3 \times q^8f^2 / t^2f =$
8. $a^7h^2 / (a^2)^3 \times a^5h^4 =$

Answers

1. $6k^{12}$
2. $2y^{8}$
3. $b^{2}j^{12}m^{3}$
4. r^{9}
5. p^{21}
6. w^{5}
7. $f^{4}q^{14}t^{3}$
8. $a^{6}h^{6}$

Take a look at the working out for each answer **here**.

Now What?

Comfortable with the concepts covered in this topic? A great next step would be to look at **Negative and Fractional Indices** for a more complete picture of the rules surrounding indices.

But When Am I Going To Use This?

Indices are used in many different situations in real life. A common example is in writing very large or very small numbers. These are often written in scientific notation, and can be stored in computers as a type of variable known as a floating point variable. Scientific notation makes heavy use of indices to keep numbers easier to work with. Floating point variables are very important in all areas of computing, including gaming physics.

Indices are also used in the calculation of areas and volumes. For example, the area of a square is the length squared, and the volume of a cube is the length cubed. This is especially important when changing units of measurement, such as from cubic metres to cubic centimetres.

Plus, indices are used in certain kinds of other measurements, including acidity (pH), the loudness of sound (decibels), or the intensity of earthquakes (the Richter scale). All of these measurements use what is known as a logarithmic scale, which relies on indices.

Other Links

Maths is Fun has a useful applet to help you understand the basic idea of indices, followed by an easy to follow summary of the rules.

- http://www.mathsisfun.com/algebra/exponent-laws.html

Another page with a lot of interactive maths problems is **www.intmath.com**. It is well structured at the top level and features are easy to find.

- http://www.intmath.com/exponents-radicals/exponent-radical.php

Laerd Mathematics gives a succinct summary of the rules, and follows this up with a wide selection of questions. Worked answers are available.

- http://mathematics.laerd.com/maths/indices-intro.php

The **Khan Academy** has a comprehensive set of video tutorials covering a large range of mathematical and other concepts, as well as questions to test your knowledge. This link takes you to the relevant section for this topic.

- https://www.khanacademy.org/math/algebra-basics/core-algebra-exponent-expressions/core-algebra-exponent-properties/v/exponent-properties-involving-products

Patrick JMT (Just Maths Tutorials) has many video tutorials covering a large range of mathematical concepts. Here are two useful videos: the first one covers the basic indices rules, and the second provides example questions.

- http://patrickjmt.com/basic-exponent-properties/
- http://patrickjmt.com/exponents-applying-the-rules-of-exponents-basic-ex-1/