Introduction to Calculus

Before You Watch

This topic introduces calculus. It presents the fundamental premise of calculus as well as some of the unique notation that is used in calculus in preparation for the other videos in this series.

You don't have to know anything about calculus before watching this video, however, it is a good idea to be familiar with the general concepts of algebra first. If you're not confident with rearranging **algebraic equations** or working with **algebraic fractions**, review the videos on those topics, then come back. You also need to be familiar with the **linear equation** before proceeding with calculus.

The Video Content

This video talks about the core concept of calculus, and explains some of the terminology. Calculus is useful when there are two quantities varying in relation to each other. The example we'll discuss here is distance varying with time.

Let's think about a moving car.

Remember from school that:

$$\text{speed} = \text{distance} / \text{time}$$

To calculate the car's speed, we'd measure the distance it travelled, and divide that by the time that passed while travelling. For instance, if it travelled 60 km in an hour, the average speed was 60 km/hr.

Another way of thinking about *distance* is the *change* in the car's *location*.

In mathematics, we often use the Greek capital letter delta, or Δ, to represent change.

So, in this example, if we call position x and time t, then:

speed = change in location / change in time

or:

Δx / Δt

This is just another way of expressing the speed, time and distance formula you would have used in school.

But we usually don't want to measure speed over the last hour or minute; we want to measure speed now, *at this instant*.

The traditional 'speed = distance / time' formula only gives us the average speed over some period of time. It does not calculate the speed now*, at this very moment.*

This is where we turn to calculus.

Calculus tells us that we need to imagine calculating the speed over smaller and smaller steps in time, over, say, the last half hour, then the last minute, the last second, the last hundredth of a second, and so on.

Our speed is still 'change in position divided by change in time', but as we calculate it over smaller and smaller steps, both the change in position and the change in time get smaller.

Then, as we look at smaller and smaller steps in time, the speed being calculated is getting closer and closer to our speed this instant.

Now imagine continuing until the change in time and the change in position become infinitesimally small. This speed, this *infinitely small change in position divided by the infinitely small change in time,* is the speed this *instant.*

To represent the changes which are now infinitely small, we replace the Greek capital letter delta Δ with a lower case d, so:

instantaneous speed = dx / dt

Calculus is all about this process of imagining the changes in distance and time getting smaller and smaller until they become infinitesimally small.

In Calculus, d means an infinitesimally small change.

In our example dt is a tiny step in *time* and dx is a tiny step in *position*, but it could be anything.

There are two main types of calculus: differential calculus and integral calculus. What we've just discussed was mainly based on differential calculus. The other topics in this series look at each of the two kinds separately.

Now What?

Now that you've been introduced to the fundamental concepts of calculus, you can explore further. As mentioned, there are two main categories of calculus: differential calculus and integral calculus. Most commonly, differential calculus is taught first, followed by integral calculus.

So, when you're familiar with the basic concepts in this video, watch **Rates of Change and Differentiation** next. Even if you already know how to differentiate, it will help you understand what differentiation means.

But When Am I Going To Use This?

Calculus is the mathematical study of how things change relative to one another. For instance, velocity (or speed) is a change of position over a change in time, and acceleration is a change in velocity over a change in time – so any motion is studied using calculus. Other examples include the flow of water through pipes over time, or changing commodity prices against demand. Because change is everywhere, the potential applications for calculus are endless, particularly in engineering and science. Calculus is necessary knowledge for any degree related to engineering or science.

Other Links

Maths is Fun has a great page that takes you through a simple problem which highlights the need for calculus to discuss changes happening around us. It then continues to explore the main two areas of calculus, differentiation and integration, and provides regular questions to test your understanding.

- https://www.mathsisfun.com/calculus/introduction.html

IntMath gives a bit of historical perspective to explain the sometimes confusing notation that is used in calculus, discussing how it is the mixed product of two mathematicians working independently. It also provides some excellent examples of applications of calculus that are in common use today, as well as helpful applets to understand both differential and integral calculus.

- http://www.intmath.com/calculus/calculus-intro.php

The **Khan Academy** has a comprehensive set of video tutorials covering a wide range of mathematical topics, as well as questions to test your knowledge. This content explains the historical development of calculus, and is also an excellent introduction to differential calculus and the concepts it is based around. From here you can further investigate differential calculus.

- https://www.khanacademy.org/math/differential-calculus/taking-derivatives/intro_differential_calc/v/newton-leibniz-and-usain-bolt

Patrick JMT (Just Maths Tutorials) has an extensive set of video tutorials covering a large range of mathematical concepts. This video introduces and explains the concept of a limit to help develop your understanding of this idea.

- https://patrickjmt.com/what-is-a-limit-basic-idea-of-limits/