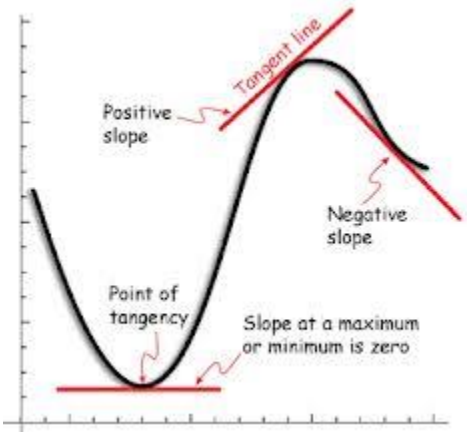
WHAT IS CALCULUS?

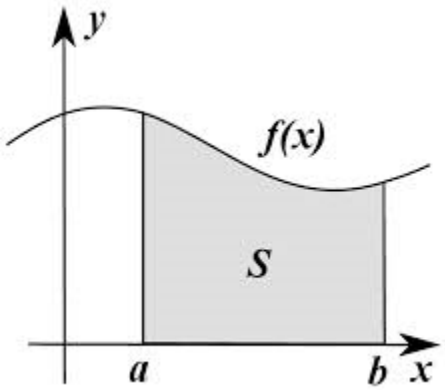
Calculus is the study of **two** very simple geometric problems:

1. **The problem of tangents (or slopes)**: Calculating the slope of the tangent line to the graph of a function at a given point P.

   Calculating slopes of curves/steepness of curves



2. **The problem of areas**: Calculate the area under the graph of a function.



One's initial reaction to this definition of calculus might be that calculus is based on seemingly abstract, obscure, impractical problems. As you will find out in this course, however, **calculus was born of necessity.** Without an understanding of Calculus, many of problems in science, technology, and business would be very difficult to solve.

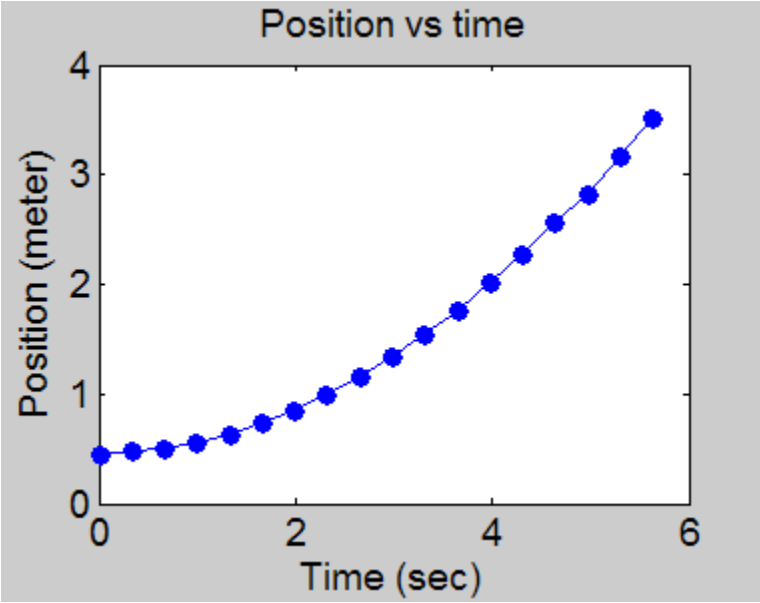
Let's look at some examples: THE IMPORTANCE OF **SLOPES**

Data from events in science, technology, and business can be graphed and then *modeled* using a formula (or a **function**).
*Do <u>you</u> remember what a **function** is?*

- the price of gasoline varies with time
- air temperature varies with elevation
- the fuel consumption of a car depends on it speed
- the velocity of a falling object depends on how long it has fallen
- the population of Earth changes over time.

All these quantities **relate to each other** in terms of a given function.
Can you think of more examples?
Think: (chemistry, business, physics, biology, technology).

Let's take the example of a student on their bike rolling down a hill (*from grade 11 Physics)*, we would expect the **position vs. time** graph to look like this:



Now the Calculus!

What good would it be to know the slope of the curve at P**?**

Remember that the slope of the position vs. time graph will give us

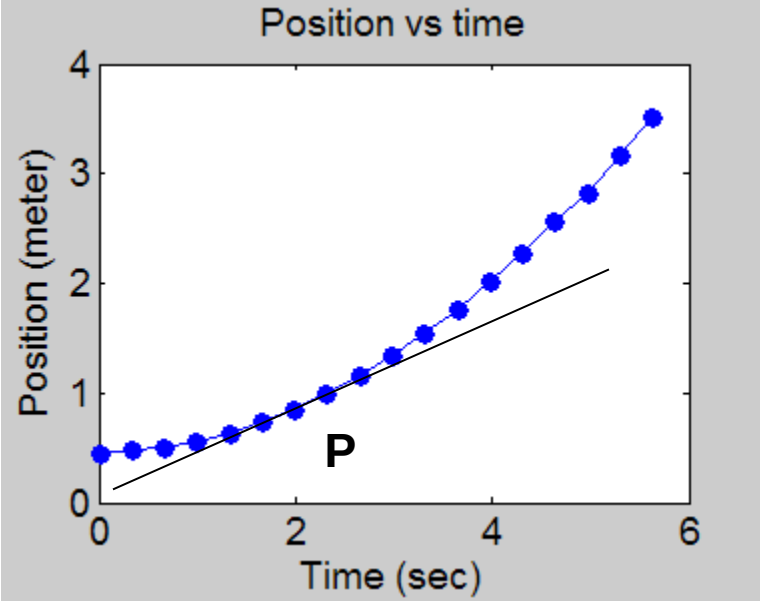
the *velocity* of the object.

If we know the slope of curve at point P we will know the velocity of the bike at point P!

Calculus let's us *derive* an equation that will give us the slope of the curve (and thus the velocity of the bike at any time t).

Velocity = 8.912(t) *(not accurate according to graph)*

This could be very useful! Yippie!



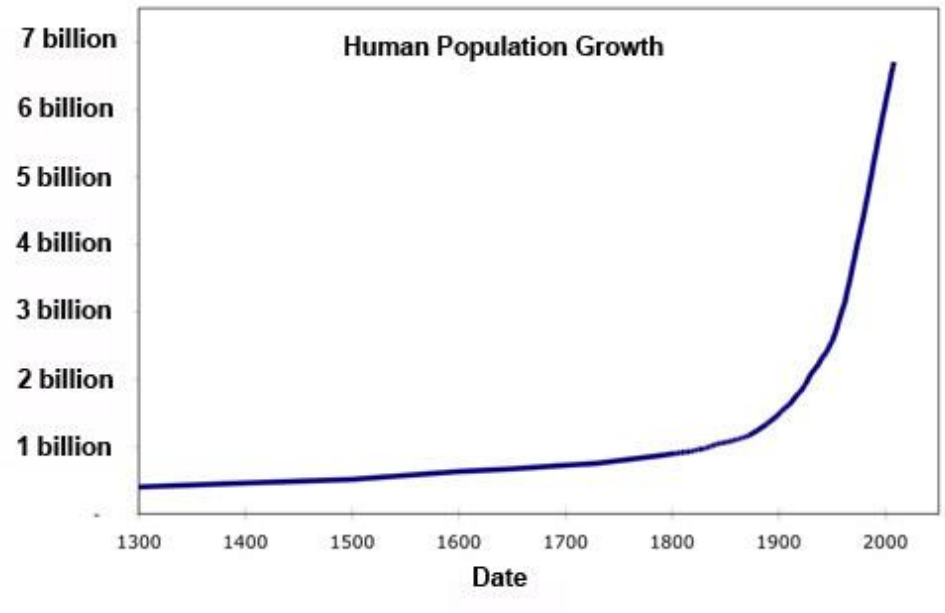
Example # 2

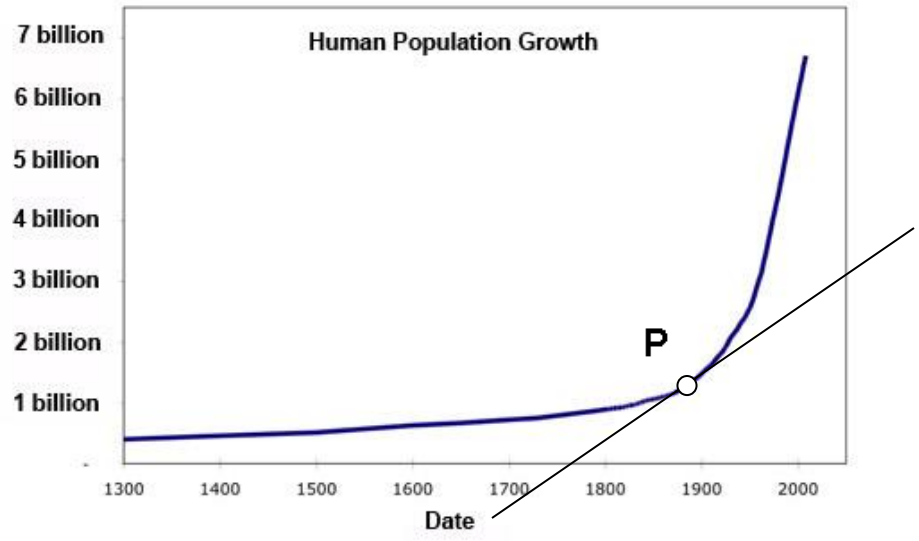
Let's take the example of the world's **population vs. time**. Generally speaking the world's population has been increasing over recent millenniums. Scientists, economists, anthropologists, and historians have followed the growth of the world's population closely. By investigating population trends, they have been able to make predictions about both past and present that are helpful when studying humans. Generally, the world's population has increased over time "*exponentially*". This means that we can model the growth of the earth's population with an equation *like* this:

$$y = 2^x$$

Where:

- y is the earth population
- x is the amount of time that has passed





Now the Calculus!

What if we wished to know the slope of the graph at point P? What would this tell us?

It would tell us the **rate at which the population was increasing** at about the year 1890. This could be some useful information!

Calculus allows us to "derive" an equation that will let us know the slope of the curved graph at any point.

Having this equation we can find out things like:

- the rate of population increase at any point in time (slope)
- the maximum or minimum population - (when slope is zero) *draw picture*
- If the population is increasing or decreasing at any point in time (positive or negative slope)

The number of applications for Calculus is endless.

Recap:

Calculus lets us calculate the *slope* of graphs and find the *area* under graphs.

We have quickly looked at how the slope of a graph is useful. Later you will learn about how calculating the **area** under a graph can be useful.

Point of interest: It is wise to constantly remind yourself that Calculus has to do with **functions** and their **graphs**. When we are doing "the math", ask your self - what it means on a graph? What would it look like? Calculus becomes far less abstract when you learn to adapt this mind set. Remember: Calculus is Graphtastic!