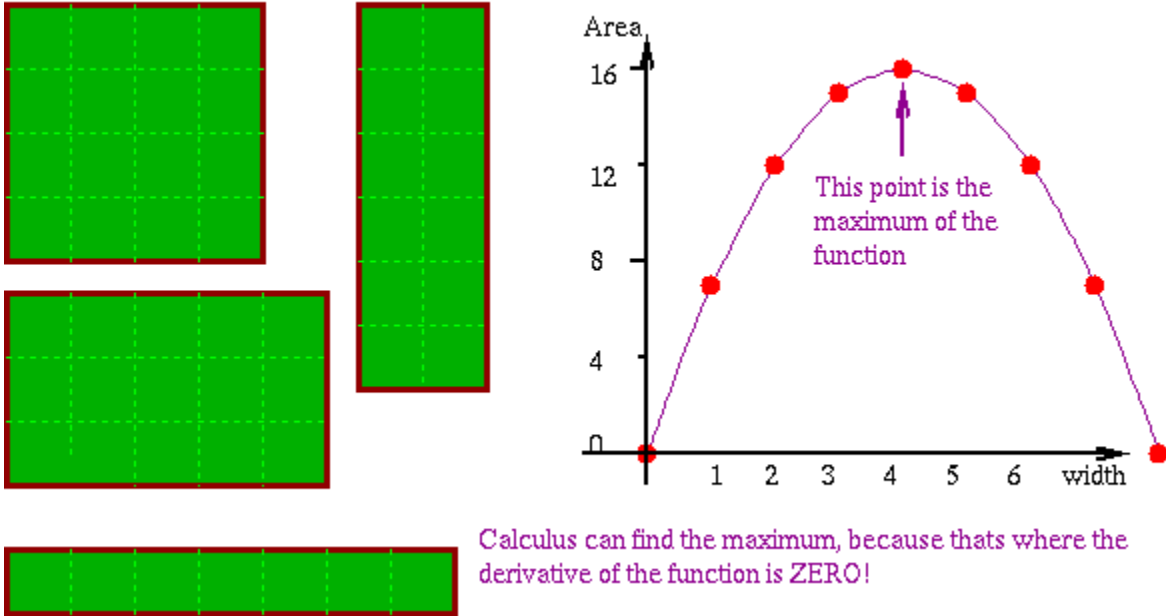


- **Extreme Values** increasing and decreasing functions, maximum and minimum values; first derivative test, and examples of max/min problems.

## Main Part of class

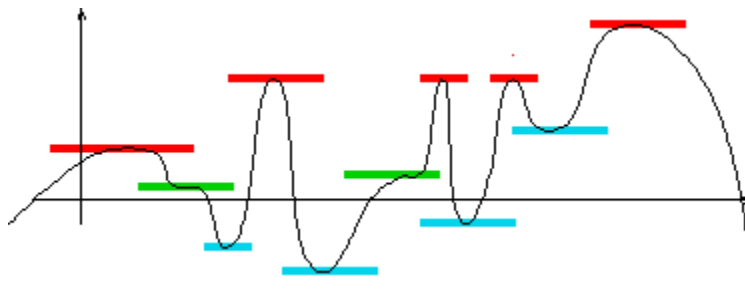
All these fields have use the same amount of fencing (Check this!) Which has biggest area?



## How to find the maximum and minimum values of a function.

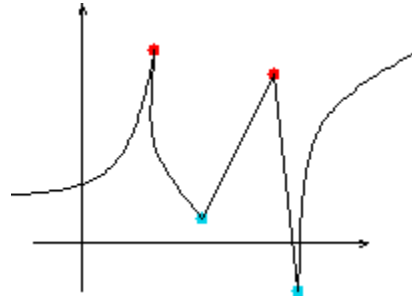
When you throw a ball up in the air, at the highest point, its speed is zero, its stopped going up, but its not quite started going down, just for an instance. In the same way, at the maximum of a function, the derivative is zero. This also happens at minimum of functions.

Here are some examples where the derivative is zero (which means that the tangent is horizontal):



In the above diagram, the red lines mark tangents at points where  $f(x)$  is a local maximum, blue lines mark points where  $f(x)$  is a local minimum, and green lines are tangents where the slope of the tangent is zero, but the point is neither a local maximum nor a local minimum; points like this are called points of **inflection**.

Actually, there is also another way you can have a maximum:



Red points mark local maximum, blue points mark local minimum, but at all these points the tangent is not defined

In this case, at the maximum, the derivative is not defined.

So, we say a number  $x$  is a **critical number** of the function if  $f'(x) = 0$ , or else if  $f'(x)$  is not defined.

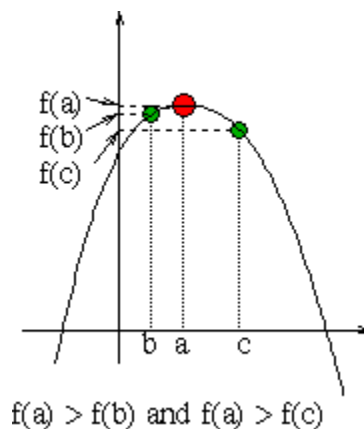
### How to tell the difference between different kind of critical numbers

You can find the critical points of a function . How do you tell if you have a maximum or a minimum?

One way is to find  $f(u)$  for every  $u$  that's a critical number there are three other ways to test:

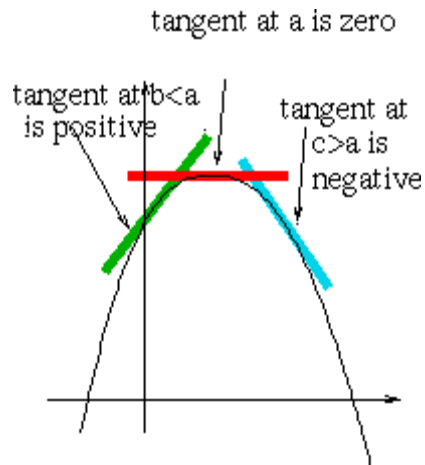
#### Method One:

Compare  $f(u)$  with  $f(v)$  for  $v$  close to  $u$ .



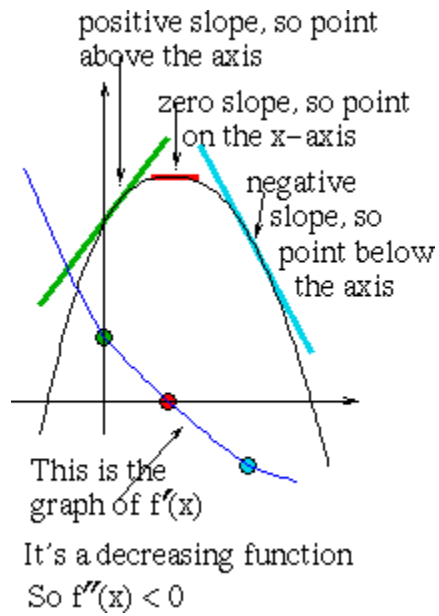
#### Method Two

Look at  $f'(v)$  for  $v$  less than and greater than  $u$ .



### Method Three

Find whether  $f'(u)$  is positive or negative.



We'll see how this compares with what happens when  $x$  is a local minimum.