

# AP Physics C Prep Day 1, Part 9: Derivatives and Tangents

## Consider a moving object

## What is a tangent?

A secant is a line connecting two points on a graph  
A tangent is a secant with a time span of 0

Slope =  $v_{avg}$  from  $t_0$  to  $t$   
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Slope of tangent =  $v$  at  $t$

## Comparison to geometry

Explanation #1:  
A secant is a line connecting two points on a graph  
A tangent is a secant with a time span of 0

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Slope =  $v$  at  $t$

secant  
secant  
secant  
secant  
tangent

## What is a tangent?

A tangent is a secant with a time span of 0.

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Slope =  $v_{avg}$  from  $t_0$  to  $t$   
Slope of tangent =  $v$  at  $t$

$$\text{slope} = \frac{x(t) - x(t_0)}{t - t_0} = \frac{\Delta x}{\Delta t}$$

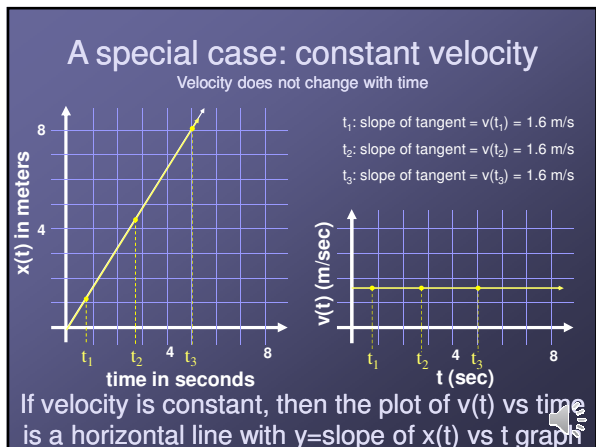
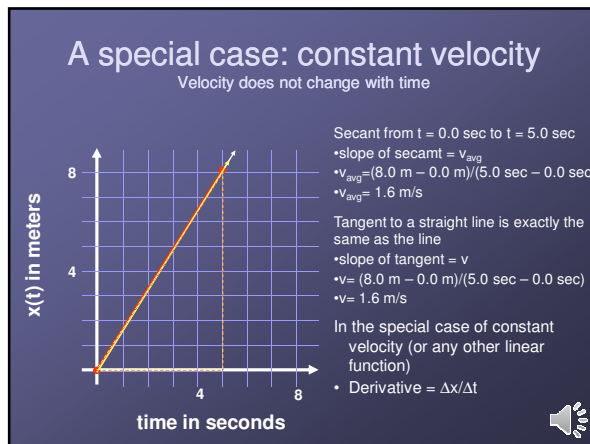
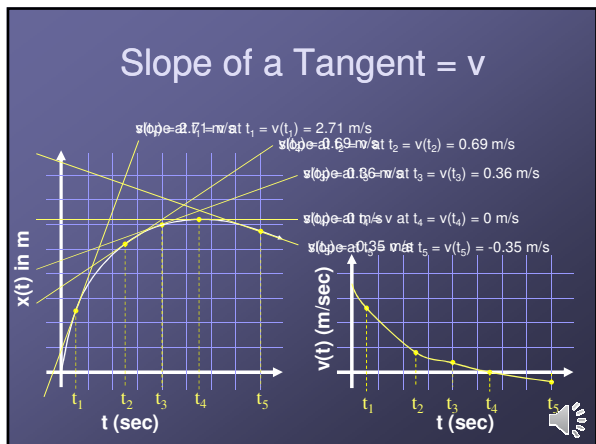
$$\text{derivative} = \lim_{t \rightarrow t_0} \frac{x(t) - x(t_0)}{t - t_0} = \frac{dx}{dt}$$

$$\frac{df}{dx} = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$$

## Slope of a Tangent = $v = dx/dt$

very steep line = very high  $v$  at  $t_1$   
moderate slope = moderate  $v$  at  $t_2$   
flat line = low slope = low  $v$  at  $t_4$   
"downhill" line = slope =  $v < 0$  at  $t_5$

$v(t_1) > v(t_2) > v(t_3) > v(t_4) = 0 > v(t_5)$



### Notation

- There are many ways to write the derivative.
- If  $f$  is a function of  $x$  then the derivative of  $f$  is...
  - The rate of change in  $f(x)$  with respect to  $x$
  - The slope of the tangent lines on the graph of  $f(x)$  vs.  $x$

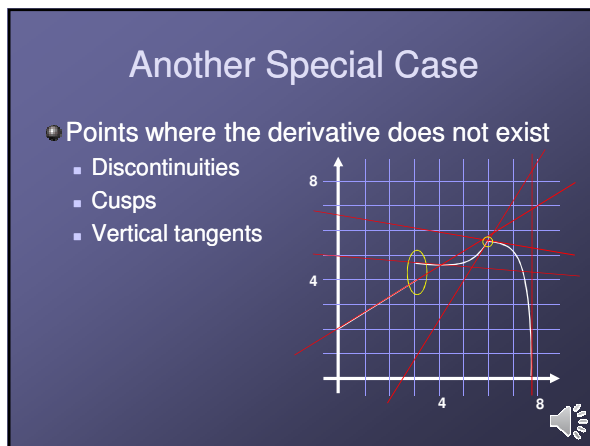
$$\text{derivative} = \frac{df}{dx} = \frac{d}{dx} f = f' = f'(x) = D_x f$$

$$\text{derivative} = \frac{dy}{dx} = \frac{d}{dx} y = y' = y'(x) = D_x y$$

### Units

- Remember a derivative is a slope
  - Specifically it is the slope of the tangent.
  - Slope =  $\Delta y / \Delta x$ 
    - Units of slope = (the units of  $y$ ) / (the units of  $x$ )
  - Units of the derivative are
 
$$\frac{\text{units on vertical axis}}{\text{units on horizontal axis}}$$

$$\frac{\text{units of the dependent variable}}{\text{units of the independent variable}}$$



## Up Next...

Video

Khan Academy  
Slope of a line secant to a curve  
[http://youtu.be/8r8Vp\\_1iB4k](http://youtu.be/8r8Vp_1iB4k)

Khan Academy  
Calculus: Derivatives 1  
<http://youtu.be/ANyVpMSSHL4>

These videos will start automatically if you are using the AP Physics C:  
Day 1 playlist

