

Warmup

On planet Zorcon an object shot straight in the air has the following position equation $s(t) = -2t^2 + 10t + 12$ where s = meters above the planet and t = seconds.

- a) What is the object's velocity at $t = 3$ seconds
- b) When will the object reach its apex?
- c) How high will it go?
- d) What is the gravity constant on Zorcon?

Graph the derivative of $\sin(x)$ using `nderiv[sin(x), x, x]`. Zoom trig
What function does this look like?

Lets prove it:

$$\frac{d}{dx} \sin x = \lim_{h \rightarrow 0} \frac{\sin(x+h) - \sin x}{h} = \lim_{h \rightarrow 0} \frac{\sin x \cosh + \cos x \sinh - \sin x}{h}$$

$$\lim_{h \rightarrow 0} \frac{\sin x \cosh - \sin x + \cos x \sinh}{h} = \lim_{h \rightarrow 0} \frac{\sin x (\cosh - 1) + \cos x \sinh}{h}$$

$$= \lim_{h \rightarrow 0} \frac{\sin x (\cosh - 1)}{h} + \lim_{h \rightarrow 0} \frac{\cos x \sinh}{h} = \sin x(0) + \cos x(1) = \cos x$$

| function | derivative | function | derivative |
|----------|-----------------|----------|------------------|
| $\sin x$ | $\cos x$ | $\cos x$ | $-\sin x$ |
| $\tan x$ | $\sec^2 x$ | $\cot x$ | $-\csc^2 x$ |
| $\sec x$ | $\sec x \tan x$ | $\csc x$ | $-\csc x \cot x$ |

Example 1: Find the derivative of $f(x) = x^2 \sin(x) + 5x$

Example 2: Find the derivative of $f(x) = x/\cos x$

Example 3: Find the equations of the lines tangent and normal to $y = 3x + \sin(x)$ at $x = \pi$