C12 - 2.0 - Derivative Laws $\frac{d}{dx} =$

$$\boxed{y' = f'(x) = \frac{dy}{dx}}$$

CHAIN RULE

Basic Derivatives

$\frac{d}{dx} c = 0$

$\frac{d}{dx}[cf(x)] = cf'(x)$

$\frac{d}{dx}[f(x) + g(x)] = f'(x) + g'(x)$

$\frac{d}{dx}[f(x) - g(x)] = f'(x) - g'(x)$

Power Rule

$\frac{d}{dx} x^n = nx^{n-1}$

Product Rule

$\frac{d}{dx}[f(x)g(x)] = f'(x)g(x) + g'(x)f(x)$

Chain Rule

$\frac{d}{dx} f(g(x)) = f'(g(x))g'(x)$

$\frac{d}{dx} f\left(g(h(x))\right) = f'\left(g(h(x))\right) g'(h(x))h'(x)$

Quotient Rule

$\frac{d}{dx}\left[\frac{f(x)}{g(x)}\right] = \frac{f'(x)g(x) - g'(x)f(x)}{[g(x)]^2}$

Exponential and Logarithmic Functions

$\frac{d}{dx} a^x = a^x \ln a$

$\frac{d}{dx} \log_a x = \frac{1}{x} \times \frac{1}{\ln a}$

Inverse Derivatives

$\frac{d}{dx} f^{-1}(x) = (f^{-1})'(x) = \frac{1}{f'(f^{-1}(x))}$

$\frac{d}{dx} e^x = e^x \cancel{\ln e} = e^x$

$\frac{d}{dx} \ln|x| = \frac{1}{x} \times \frac{1}{\cancel{\ln e}} = \frac{1}{x}$

$Note: \ln e = 1$

Trigonometric Functions

$\frac{d}{dx} sinx = cosx$

$\frac{d}{dx} secx = secxtanx$

PSST

$\frac{d}{dx} tanx = \sec^2 x$

$\frac{d}{dx} cosx = -sinx$

$\frac{d}{dx} cscx = -cscx\, cotx$

$\frac{d}{dx} cotx = -\csc^2 x$

Inverse Trigonometric Functions

$\frac{d}{dx} \sin^{-1} x = \frac{1}{\sqrt{1 - x^2}}$

$\frac{d}{dx} \sec^{-1} x = \frac{1}{|x|\sqrt{x^2 - 1}}$

$\frac{d}{dx} \tan^{-1} x = \frac{1}{1 + x^2}$

$\frac{d}{dx} \cos^{-1} x = -\frac{1}{\sqrt{1 - x^2}}$

$\frac{d}{dx} \csc^{-1} x = -\frac{1}{|x|\sqrt{x^2 - 1}}$

$\frac{d}{dx} \cot^{-1} x = -\frac{1}{1 + x^2}$

C12 - 2.0 - Derivative Formula Notes

Find the equation of the tangent line to x^2 *at* $x = 1$.

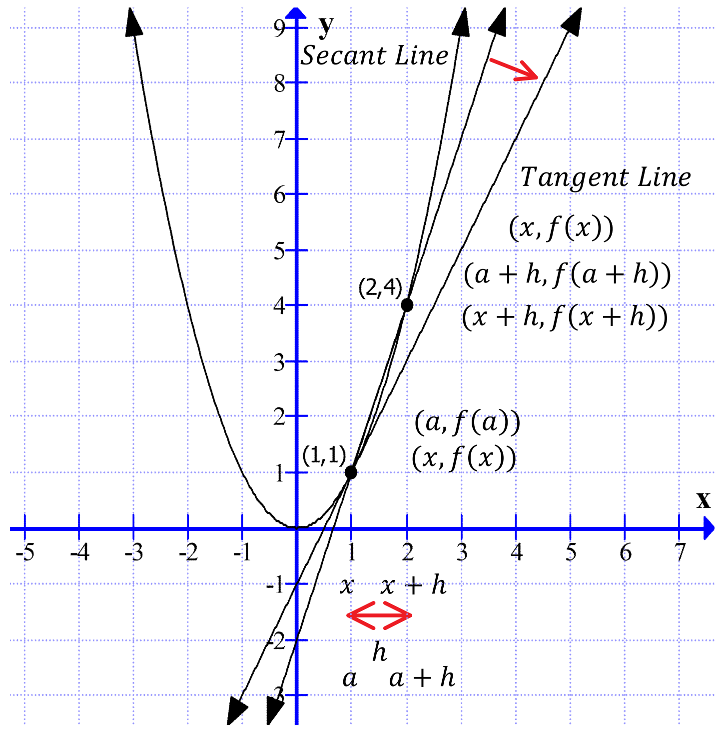
$$m = f'(a) = \lim_{x \to a} \frac{f(x) - f(a)}{x - a}$$

$f(x) = x^2$ $\quad a = 1 \quad (1,1) \quad f(1) = 1$

$$m = \frac{y_2 - y_1}{x_2 - x_1} \qquad \frac{f(x_2) - f(x_1)}{x_2 - x_1}$$

x	y
1	1

$$m = f'(1) = \lim_{x \to 1} \frac{x^2 - f(1)}{x - 1}$$
$$\lim_{x \to 1} \frac{x^2 - 1}{x - 1}$$
$$\lim_{x \to 1} \frac{(x+1)(x-1)}{(x-1)}$$
$$\lim_{x \to 1} x + 1$$
$$1 + 1$$
$$m = f'(1) = 2$$



$$y - y_1 = m(x - x_1)$$
$$y - 1 = 2(x - 1)$$
$$y = 2x - 1$$

$$m = f'(a) = \lim_{h \to 0} \frac{f(a+h) - f(a)}{h}$$

$$m = f'(1) = \lim_{h \to 0} \frac{f(1+h) - f(1)}{h}$$
$$\lim_{h \to 0} \frac{(1+h)^2 - (1^2)}{h}$$
$$\lim_{h \to 0} \frac{1 + 2h + h^2 - 1}{h}$$
$$\lim_{h \to 0} \frac{2h + h^2}{h}$$
$$\lim_{h \to 0} \frac{h(2+h)}{h}$$
$$\lim_{h \to 0} 2 + h$$
$$2 + 0$$
$$m = f'(1) = 2$$

$$f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$$

Definition of the Derivative

$$\lim_{h \to 0} \frac{(x+h)^2 - (x^2)}{h}$$
$$\lim_{h \to 0} \frac{x^2 + 2xh + h^2 - x^2}{h}$$
$$\lim_{h \to 0} \frac{2xh + h^2}{h}$$
$$\lim_{h \to 0} \frac{\cancel{h}(2x + h)}{\cancel{h}}$$
$$\lim_{h \to 0} 2x + \cancel{h}$$
$$f'(x) = 2x$$

$f(x + h) = (x + h)^2$

Foil
Simplify
Factor, Simplify
Substitute

Power Rule

$y = x^2$
$y' = 2x$

$m = 2(1)$

$m = 2$

$f'(1) = 2(1) \qquad x = 1$

$f'(1) = 2 \qquad m = 2$

Slope of Tangent