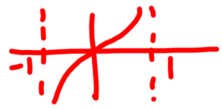
$$\lim_{x\to 0} \frac{2\sin 2x}{3x}\cdot\frac{2}{2} = \lim_{x\to 0} \frac{4}{3}\cdot\overbrace{\frac{\sin 2x}{2x}}^{\to 1} = \frac{4}{3}$$

$$\lim_{x\to 0} \frac{2\sin 2x}{3x} = \lim_{x\to 0} \frac{2(2\sin x\cos x)}{3x} =$$

$$= \lim_{x\to 0} \frac{4}{3}\cdot\overbrace{\frac{\sin x}{x}}^{\to 1}\cdot\frac{\overset{\to 1}{\cos x}}{1} = \frac{4}{3}$$

52. $f(x) = \tan\frac{\pi x}{2}$



$\frac{\pi}{\pi/2} = 2$

discuss the (dis) continuity

f has non-removable vertical asymptote discontinuities at all $x = 2k+1,\ k\in\mathbb{Z}$

f is continuous on all intervals of the form $(2k-1, 2k+1)$

62. $f(x)=\frac{1}{\sqrt{x}}, g(x)=x-1$

(both continuous on their domains)

Discuss the continuity of $f(g(x))$.

$f(g(x))=\frac{1}{\sqrt{x-1}}$ is also continuous on its domain

$(1,\infty)$

64. $f(x)=\sin x$; $g(x)=x^2$

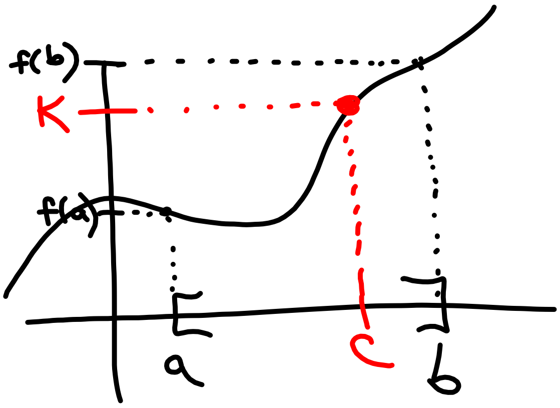
discuss the continuity of $f(g(x))$

$f(g(x))=\sin(x^2)$

composition of two functions continuous on $(-\infty,\infty)$ is cts. on $(-\infty,\infty)$

Intermediate Value Theorem

If *f* is continuous on the closed interval [*a*,*b*] and *k* is any number between *f(a)* and *f(b)*, then there is at least one number *c* in [*a*,*b*] such that *f(c)=k*.



Does the IVT guarantee a zero in the given interval?

76. $f(x) = x^3 + 3x - 2$, $[0,1]$

$f(0) = -2 < 0$
$f(1) = 2 > 0$

$\Rightarrow$ IVT applies & guarantees a zero in $(0,1)$

84. $f(x) = x^2 - 6x + 8$; $[0,3]$; $f(c) = 0$

86. $f(x) = \dfrac{x^2+x}{x-1}$, $\left[\frac{5}{2}, 4\right]$, $f(c) = 6$

cts ✓

$f(5/2) = \dfrac{\left(\frac{5}{2}\right)^2 + \frac{5}{2}}{\frac{5}{2} - 1} = \dfrac{\frac{25}{4} + \frac{10}{4}}{\frac{5}{2} - \frac{2}{2}} = \dfrac{\frac{35}{4}}{3/2} = \dfrac{35}{\cancel{4}_2} \cdot \dfrac{\cancel{2}}{3} = \dfrac{35}{6} < 6$

$f(4) = \dfrac{4^2+4}{4-1} = \dfrac{20}{3} > 6$ $\Rightarrow$ IVT guarantees a $c \in (5/2, 4)$ s.t. $f(c) = 6$.

1.5

Infinite Limits

$$\lim_{x \to c} f(x) = \pm\infty$$

means the function increases or decreases without bound; i.e. the graph of the function approaches a vertical asymptote

Finding Vertical Asymptotes

x-values at which a function is undefined result in either holes in the graph or vertical asymptotes. Holes result when a function can be rewritten so that the factor which yields the discontinuity cancels. Factors that can't cancel yield vertical asymptotes.

Examples:

$f(x) = \frac{1}{x(x+3)}$ has vertical asymptotes at $x = 0$ and $x = 3$

$f(x) = \frac{(x+2)(x+3)}{x(x+3)}$ has a vertical asymptote at $x = 0$ and a hole at $x = -3$

Rules involving infinite limits

Let $\lim_{x \to c} f(x) = \infty$ *and* $\lim_{x \to c} g(x) = L$

1. $\lim_{x \to c} [f(x) \pm g(x)] = \infty$

2. $\lim_{x \to c} [f(x)g(x)] = \begin{cases} \infty, & L > 0 \\ -\infty, & L < 0 \end{cases}$

3. $\lim_{x \to c} \frac{g(x)}{f(x)} = 0$

Find the vertical asymptotes (if any).

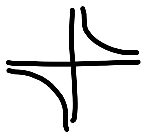
14. $f(x) = \dfrac{-4x}{x^2+4}$ none

24. $h(x) = \dfrac{x^2-4}{x^3+2x^2+x+2} = \dfrac{(x-2)\cancel{(x+2)}}{\cancel{(x+2)}(x^2+1)}$ none

$x^2(x+2) + (x+2)$

28. $g(\theta) = \dfrac{\tan\theta}{\theta}$

42. $\lim\limits_{x\to 0^-}\left(x^2 - \frac{1}{x}\right) = \lim\limits_{x\to 0^-} x^2 - \lim\limits_{x\to 0^-} \frac{1}{x}$



$= 0 - (-\infty) = \boxed{\infty}$

46. $\lim\limits_{x\to 0} \dfrac{x+2}{\cot x}$

Differential Calculus Quiz #6 Name
4th Period 27 Nov. 2018

2 pts

1. Discuss the continuity of the function (identify all discontinuities, if any, as removable or non-removable).

$$f(x) = \frac{x^2 - 7x + 10}{x^2 - 3x + 2} = \frac{(x-5)\cancel{(x-2)}}{\cancel{(x-2)}(x-1)}$$

f has a removable discontinuity @ x=2
& a non-removable discontinuity @ x=1
} 0.25 ea

f is continuous on $(-\infty, 1) \cup (1, 2) \cup (2, \infty)$

0.3 ea

2. Determine if the Intermediate Value Theorem guarantees a c in the interval $[-2, 3]$ such that $f(c) = -4$, and if so, find all such values of c.

$f(x) = x^2 - 7x + 2$

f is continuous on $[-2,3]$ •

$f(-2) = (-2)^2 - 7(-2) + 2 = 20$

$f(3) = 3^2 - 7(3) + 2 = -10$

Since $f(3) < -4 < f(-2)$
• IVT guarantees a $c \in (-2,3)$ s.t. $f(c) = -4$

$x^2 - 7x + 2 = -4$ •

$x^2 - 7x + 6 = 0$

$(x-6)(x-1) = 0$

$x = 6, \; x = 1$

$\notin (-2,3)$

$\boxed{c = 1}$ •

0.25 ea

Find the vertical asymptotes (if any).

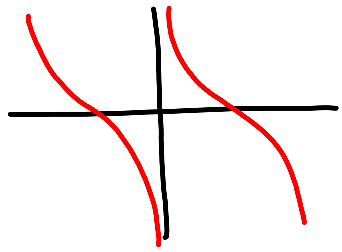
28. $g(\theta) = \frac{\tan\theta}{\theta}$

$g(\theta)$ has vertical asymptotes @ $x = \frac{(2k+1)\pi}{2}, \; k \in \mathbb{Z}$

$$\lim_{\theta \to 0} \frac{\tan\theta}{\theta} = \lim_{\theta \to 0} \frac{\sin\theta}{\theta} \cdot \frac{1}{\cos\theta} = 1 \cdot 1 = 1$$

(hole in graph @ $(0,1)$)

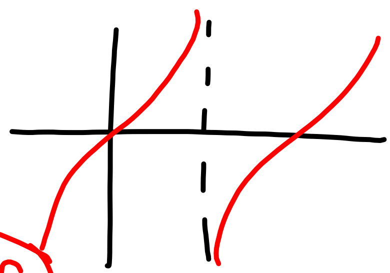
46. $\lim\limits_{x\to 0} \dfrac{x+2 \to 2}{\cot x \to \pm\infty} \to 0$



$= \lim\limits_{x\to 0} (x+2)\tan x$

$= 2 \cdot 0 = \boxed{0}$

48. $\lim\limits_{x\to \frac{1}{2}} x^2 \tan \pi x$

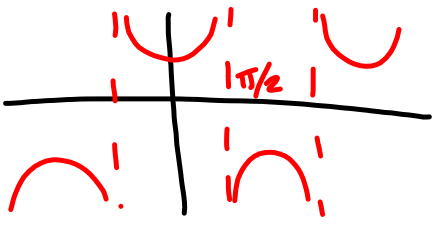


$= \left(\lim\limits_{x\to\frac{1}{2}} x^2\right)\left(\lim\limits_{x\to\frac{1}{2}} \tan\pi x\right)$

$= \frac{1}{4} \cdot \text{DNE} = \text{DNE}$

$\lim\limits_{x\to\frac{1}{2}^-} x^2 \tan\pi x = \infty$, $\lim\limits_{x\to\frac{1}{2}^+} x^2\tan\pi x = -\infty$

52. $\lim\limits_{x\to 3^+} \sec\frac{\pi x}{6}$



$= \lim\limits_{x\to\frac{\pi}{2}^+} \sec x$

$= \boxed{-\infty}$

2.1 The Derivative & The Tangent Line Problem

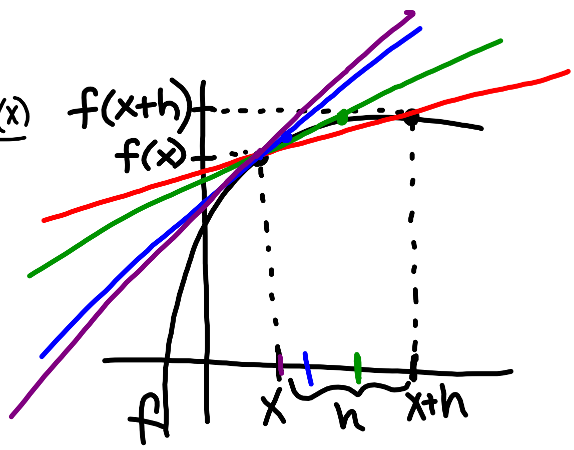
secant line crosses through a function at two points

slope of the secant line:

$$\frac{f(x+h)-f(x)}{x+h-x}=\frac{f(x+h)-f(x)}{h}$$

what happens as $h \to 0$?

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



As $h \to 0$, the secant line approximates the tangent line, and the limit is the slope of the tangent line and we call it **the derivative of f at x**.

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

$f''(x) = y''$

$\frac{d^2y}{dx^2}$

$y^{(n)} = f^{(n)}(x)$

$\frac{d^ny}{dx^n}$

$f'(x)$	"f prime of x"
$\frac{dy}{dx} = \frac{d}{dx}[y]$	"derivative of y with respect to x"
y'	"y prime"
$\frac{d}{dx}[f(x)]$	"the derivative with respect to x of $f(x)$"
$D_x[y]$	"the partial derivative with respect to x of y"

The Derivative

The slope of the tangent line to the graph of f at the point $(c, f(c))$ is given by:

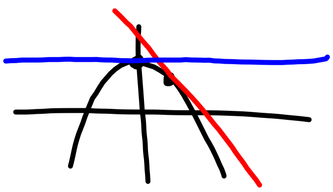
$$m = \lim_{\Delta x \to 0} \frac{\Delta y}{\Delta x} = \lim_{\Delta x \to 0} \frac{f(c+\Delta x) - f(c)}{\Delta x} = f'(c)$$

The derivative of f at x is given by

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

8. $g(x) = 5 - x^2$

find slope of tangent line at the points $(2,1)$ & $(0,5)$



$$g'(c) = \lim_{h \to 0} \frac{g(c+h) - g(c)}{h}$$

@ $(2,1)$ $c=2$; $g(c)=1$

$$g'(2) = \lim_{h \to 0} \frac{5-(2+h)^2 - 1}{h} = \lim_{h \to 0} \frac{5-(4+4h+h^2)-1}{h}$$

$$= \lim_{h \to 0} \frac{-4h-h^2}{h} = \lim_{h \to 0} \frac{\cancel{h}(-4-h)}{\cancel{h}} = \boxed{-4}$$

@ $(0,5)$:

$$g'(0) = \lim_{h \to 0} \frac{5-(0+h)^2-5}{h} = \lim_{h \to 0} \frac{-h^2}{h} = \lim_{h \to 0}(-h) = \boxed{0}$$

20. $f(x) = x^3 + x^2$

find the derivative

$$f'(x) = \lim_{h\to 0} \frac{f(x+h) - f(x)}{h} = \lim_{h\to 0} \frac{(x+h)^3 + (x+h)^2 - (x^3+x^2)}{h}$$

$$= \lim_{h\to 0} \frac{\cancel{x^3} + 3x^2h + 3xh^2 + h^3 + \cancel{x^2} + 2xh + h^2 - \cancel{x^3} - \cancel{x^2}}{h}$$

$$= \lim_{h\to 0} \frac{\cancel{h}(3x^2 + 3xh + h^2 + 2x + h)}{\cancel{h}}$$

$$= \lim_{h\to 0} (3x^2 + 3x(0) + 0^2 + 2x + 0) = \boxed{3x^2 + 2x}$$

Binomial Theorem

$$\binom{n}{k} = \frac{n!}{k!(n-k)!}$$

$$(a+b)^n = \sum_{k=0}^{n} \binom{n}{k} a^{n-k} b^k$$

$(a+b)^0 = 1$

$(a+b)^1 = a+b$

$(a+b)^2 = a^2 + 2ab + b^2$

$(a+b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$

1
1 1
1 2 1
1 3 3 1
1 4 6 4 1
1 5 10 10 5 1

Find the equation of the tangent line to

$f(x)=x^3-x$ at the point $(2,6)$.

$$f'(x)=\lim_{h\to 0}\frac{(x+h)^3-(x+h)\ -(x^3-x)}{h}=$$

$$=\lim_{h\to 0}\frac{\cancel{x^3}+3x^2h+3xh^2+h^3\ -\cancel{x}-h\ \ -\cancel{x^3}+\cancel{x}}{h}$$

$$=\lim_{h\to 0}\frac{\cancel{h}(3x^2+3xh+h^2-1)}{\cancel{h}}=3x^2+3x(0)+0^2-1$$

$$f'(x)=3x^2-1$$

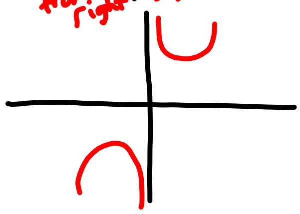
slope of tangent line @ $(2,6)$: $f'(2)=3(2)^2-1=\boxed{11}$

$$f(x)=\frac{x}{5\sin(x+1)}=\left(\frac{1}{5}x\right)\left(\csc(x+1)\right)$$

from left $\to -\infty$

from right $\to \infty$

$-$



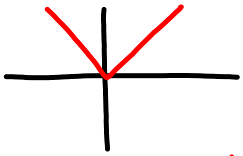
$$\lim_{x\to -1^-}f(x)=\infty$$

$$\lim_{x\to -1^+}f(x)=-\infty$$

2.1 Differentiability & Continuity

Alternative definition of the derivative at the point $(c, f(c))$:

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



All differentiable functions are continuous, but not all continuous functions are differentiable.

e.g. $f(x) = |x|$ continuous on $(-\infty, \infty)$

$$\lim_{x \to 0^-} \frac{|x| - |0|}{x - 0} = \lim_{x \to 0^-} \frac{|x|}{x} = -1$$

$$\lim_{x \to 0^+} \frac{|x| - |0|}{x - 0} = \lim_{x \to 0^+} \frac{|x|}{x} = 1$$

$\lim_{x \to 0} \frac{|x| - |0|}{x - 0}$ DNE

& derivative defined by that limit does not exist

$f(x) = \sqrt{x}$

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

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

$$= \lim_{x \to 0^+} \frac{\sqrt{x}}{x} = \lim_{x \to 0^+} \frac{1}{\sqrt{x}}$$

$$= \infty$$

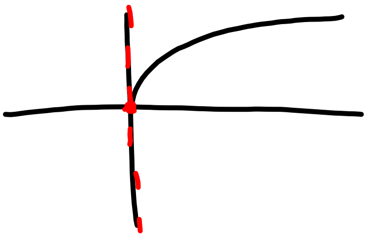
$$\frac{\sqrt{x}}{x} \cdot \frac{\sqrt{x}}{\sqrt{x}} = \frac{x}{x\sqrt{x}} = \frac{1}{\sqrt{x}}$$

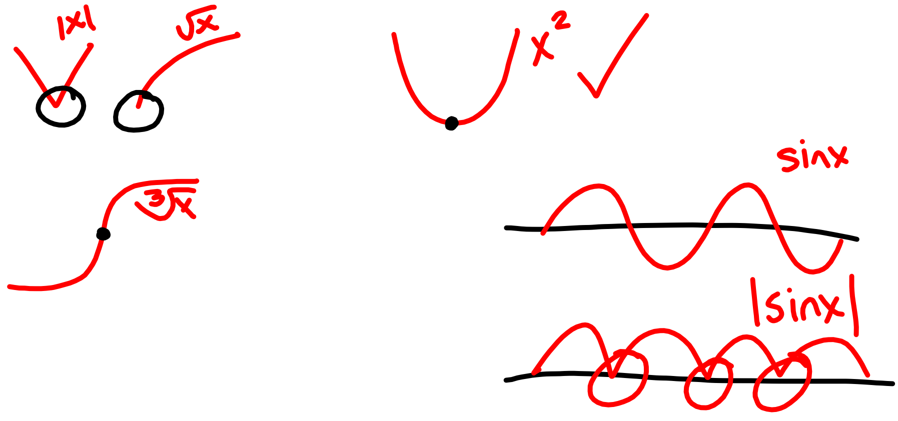
$$\frac{\sqrt{x}}{x} = \frac{x^{1/2}}{x^1} = \frac{1}{x^{1-1/2}} = \frac{1}{x^{1/2}} = \frac{1}{\sqrt{x}}$$

$$\frac{x^m}{x^n} = \frac{x^{m-n}}{1} = \frac{1}{x^{n-m}}$$

$\sqrt{x}$ has a vertical tangent line @ $(0,0)$

$\Rightarrow \sqrt{x}$ is not differentiable @ $(0,0)$





Is f differentiable at (-3,0)? Explain why or why not.

$f(x) = |x+3|$ No.

$$\lim_{x\to -3^-} \frac{|x+3| - |-3+3|}{x-(-3)} = \lim_{x\to -3^-} \frac{|x+3|}{x+3} = -1$$

$$\lim_{x\to -3^+} \frac{|x+3|}{x+3} = 1$$

$$f'(-3) = \lim_{x\to -3} \frac{|x+3|}{x+3}$$ does not exist

$\Rightarrow$ f is not differentiable @ (-3,0)

2.2 Basic Differentiation Rules

1. The derivative of a constant function is zero, i.e.,

for $c \in \mathbb{R}$, $\frac{d}{dx}[c] = 0$

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

$$\frac{d}{dx}[c] = \lim_{h \to 0} \frac{c - c}{h} = \lim_{h \to 0} \frac{0}{h} = \lim_{h \to 0} (0) = \boxed{0}$$

Examples:

$f(x) = 3x^2$

$$f'(x) = 3 \cdot [x^2]' = 3(2x) = \boxed{6x}$$

$f(x) = \frac{3}{x} = 3x^{-1}$

$$f'(x) = -3x^{-2} = \boxed{\frac{-3}{x^2}}$$

$g(x) = 2x^3 - x^2 + 3x$

$$g'(x) = 6x^2 - 2x + 3$$

$y = 4x^{3/2} - 5x^4 + 2x^{\frac{1}{3}} - 7$

$$y' = 4\left(\frac{3}{2}x^{1/2}\right) - 5(4x^3) + 2\left(\frac{1}{3}x^{-2/3}\right) - 0$$

$$= \boxed{6x^{1/2} - 20x^3 + \frac{2}{3}x^{-2/3}}$$

$$= 6\sqrt{x} - 20x^3 + \frac{2}{3\sqrt[3]{x^2}}$$

2. Power Rule for $n\epsilon\mathbb{Q}$, $\frac{d}{dx}[x^n] = nx^{n-1}$

Special case: $\frac{d}{dx}[x] = 1$

$\frac{d}{dx}[x^1] = 1x^0 = 1$

Proof:

Recall the binomial expansion:

$$(a+b)^n = a^n + na^{n-1}b + \frac{n(n-1)}{2}a^{n-2}b^2 + \cdots + \frac{n!}{k!\,(n-k)!}a^{n-k}b^k + \cdots + b^n$$

$$\frac{d}{dx}[x^n] = \lim_{h \to 0} \frac{(x+h)^n - x^n}{h}$$

$$= \lim_{h \to 0} \frac{\cancel{x^n} + nx^{n-1}h + \frac{n(n-1)}{2}x^{n-2}h^2 + \cdots + h^n - \cancel{x^n}}{h}$$

$$= \lim_{h \to 0} \frac{\cancel{h}\left(nx^{n-1} + \frac{n(n-1)}{2}x^{n-2}h + \cdots + h^{n-1}\right)}{\cancel{h}}$$

$$= nx^{n-1} + 0 + 0 + \cdots + 0 = \boxed{nx^{n-1}}$$

Examples:

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

$\frac{d}{dx}[x^7] = 7x^6$

$\frac{d}{dx}[\pi^3] = 0$ (π^3 is a constant and $[c]' = 0$

$\frac{d}{dx}[2e] = 0$

$\frac{d}{dx}[\sqrt{x}] = \frac{d}{dx}[x^{1/2}] = \frac{1}{2}x^{-1/2} = \boxed{\frac{1}{2\sqrt{x}}}$

$\frac{d}{dx}\left[\frac{1}{x^3}\right] = \frac{d}{dx}[x^{-3}] = -3x^{-4} = \boxed{-\frac{3}{x^4}}$

$$\lim_{x\to 0} \frac{12(1-\cos x)}{x^2} \cdot \frac{1+\cos x}{1+\cos x}$$

$$= \lim_{x\to 0} \frac{12(1-\cos^2 x)}{x^2(1+\cos x)} = \lim_{x\to 0} \frac{12}{1+\cos x} \cdot \frac{\sin^2 x}{x^2} \nearrow 1$$

$$= \frac{12}{1+1} = 6$$

$$f(x) = \begin{cases} -4\dfrac{\sin x}{x}, & x<0 \\ a+7x, & x\geq 0 \end{cases}$$

$$\lim_{x\to 0^-}\left(-4\frac{\sin x}{x}\right) = \lim_{x\to 0^+}(a+7x)$$

$$\boxed{-4 = a}$$

$$\lim_{x\to -5^-} 6 = \lim_{x\to -5^+}(ax+b) \to 6 = -5a+b$$

$$\lim_{x\to 1^-}(ax+b) = \lim_{x\to 1^+}(-6) \to a+b=-6$$

$$b = -6-(-2) \qquad 5a-b = -6$$

$$= -4 \qquad 6a = -12$$

$$a = -2$$

$$\frac{x^2-5x}{x-3} = 6 \qquad x=9, 2$$

$$x^2-5x = 6(x-3)$$

$$x^2-5x = 6x-18$$

$$x^2-11x+18=0$$

$$(x-9)(x-2)=0$$

$$\lim_{x \to c^-} (4 - x^2) = \lim_{x \to c^+} x$$

$$4 - c^2 = c$$

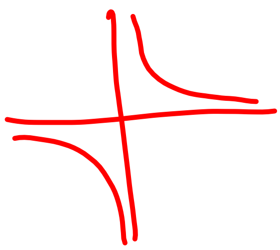
$$0 = c^2 + c - 4$$

$$c = \frac{-1 \pm \sqrt{1^2 - 4(1)(-4)}}{2(1)} = \frac{-1 \pm \sqrt{17}}{2}$$

$$\lim_{x \to 0^-} x^2 - \lim_{x \to 0^-} \frac{1}{x}$$

$$0 - (-\infty)$$

$$= \boxed{\infty}$$



$$g(x) = 9 - x^2$$
$$g'(x) = -2x$$
$$m = g'(4) = \boxed{-8}$$

$$\lim_{h \to 0} \frac{\frac{2}{x+h-3} - \frac{2}{x-3}}{h} = \lim_{h \to 0} \frac{2(x-3) - 2(x+h-3)}{h(x\ 3)(x+h-3)}$$

$$= \lim_{h \to 0} \frac{\cancel{2x} - \cancel{6} - \cancel{2x} - 2\cancel{h} + \cancel{6}}{\cancel{h}(x-3)(x+h-3)} = \frac{-2}{(x-3)(x-3)}$$

$f(x) = x^2 + 5x + 2$, $(-5, 2)$

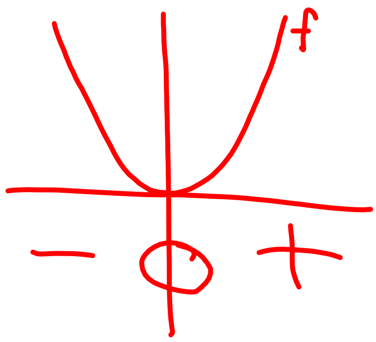
$f'(x) = 2x + 5$

$m = f'(x) = 2(-5) + 5 = -5$

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

$y - 2 = -5(x - (-5))$

$y = -5x - 23$



$y = x^2$

$y' = 2x$

$f(x)=x^2-9\ ;\ x=5$

$$\lim_{x\to 5}\frac{(x^2-9)-(5^2-9)}{x-5}=\lim_{x\to 5}\frac{x^2-25}{x-5}$$

$$=\lim_{x\to 5}\frac{\cancel{(x-5)}(x+5)}{\cancel{x-5}}=5+5=\boxed{10}$$

$$\lim_{x\to 2}\frac{\frac{3}{x^2}-\frac{3}{2^2}}{x-2}=\lim_{x\to 2}\frac{3\cdot 4-3\cdot x^2}{(x-2)\,4x^2}$$

$$=\lim_{x\to 2}\frac{-3(x^2-4)}{(x-2)\cdot 4x^2}=\lim_{x\to 2}\frac{-3\cancel{(x-2)}(x+2)}{\cancel{(x-2)}4x^2}$$

$$=\frac{-3(2+2)}{4(2^2)}=-3/4$$

$$f(x)=\frac{2x}{x+4}$$

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

$$=\lim_{h\to 0}\frac{\frac{2(x+h)}{(x+h)+4}-\frac{2x}{x+4}}{h}$$

$$=\lim_{h\to 0}\frac{\frac{2(x+h)}{(x+h)+4}\cdot\frac{x+4}{x+4}-\frac{2x}{x+4}\cdot\frac{x+h+4}{x+h+4}}{\frac{h}{1}}$$

$$=\lim_{h\to 0}\frac{2(x+h)(x+4)-2x(x+h+4)}{(x+4)(x+h+4)}\cdot\frac{1}{h}$$

$$=\lim_{h\to 0}\frac{2(x^2+4x+hx+4h)-2x^2-2xh-8x}{h(x+4)(x+h+4)}$$

$$=\lim_{h\to 0}\frac{\cancel{2x^2}+\cancel{8x}+\cancel{2h}x+8h-\cancel{2x^2}-\cancel{2xh}-\cancel{8x}}{h(x+4)(x+h+4)}$$

$$=\lim_{h\to 0}\frac{8\cancel{h}}{\cancel{h}(x+4)(x+h+4)}=\boxed{\frac{8}{(x+4)^2}}$$

$$f(x)=\begin{cases}x^2-5 & , x\le c\\ \frac{\sqrt{x}-5}{x-5} & , x>c\end{cases}$$

$$\lim_{x\to c^-}(x^2-5)=\lim_{x\to c^+}\frac{\sqrt{x}-5}{x-5}\cdot\frac{\sqrt{x}+5}{\sqrt{x}+5}$$

$$c^2-5=\lim_{x\to c^+}\frac{x-25}{(x-5)(\sqrt{x}+5)}$$

The Derivative

The slope of the tangent line to the graph of f at the point $(c, f(c))$ is given by:

$$m = \lim_{\Delta x \to 0} \frac{\Delta y}{\Delta x} = \lim_{\Delta x \to 0} \frac{f(c+\Delta x) - f(c)}{\Delta x}$$

The derivative of f at x is given by

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

2.2 Basic Differentiation Rules

1. The derivative of a constant function is zero, i.e., for $c \in \mathbb{R}$, $\frac{d}{dx}[c] = 0$

2. Power Rule for $n \epsilon \mathbb{Q}$, $\frac{d}{dx}[x^n] = nx^{n-1}$

3. Constant Multiple Rule $\in \mathbb{R}$, $\frac{d}{dx}[cf(x)] = cf'(x)$

4. Sum & Difference Rules $\frac{d}{dx}[f(x) \pm g(x)] = f'(x) \pm g'(x)$

Derivatives of Trig Functions

1. $\frac{d}{dx}[\sin x] = \cos x$
2. $\frac{d}{dx}[\cos x] = -\sin x$
3. $\frac{d}{dx}[\tan x] = \sec^2 x$
4. $\frac{d}{dx}[\cot x] = -\csc^2 x$
5. $\frac{d}{dx}[\sec x] = \sec x \tan x$
6. $\frac{d}{dx}[\csc x] = -\csc x \cot x$