Differentiation = taking a derivative

$f(x) \rightarrow f'(x)$

$y \rightarrow \frac{dy}{dx}$

$f(x) \rightarrow \frac{d}{dx} f(x)$

$f(x) \rightarrow D_x$

$f(x) = x^2 \quad f'(x) = 2x' = 2x$

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

$x^3 \rightarrow 3x^2$

$f(x) = 5x^4 - \frac{1}{2}x^2 + 3$ $\quad x = 2$

$f'(x) = 20x^3 - x + 0$

$20x^3 - x$

$160 - 2 = 158$

$f(x) \quad 5e^x - \sin(x) + x^{-2}$

$\downarrow$

$f'(x) \quad 5e^x - \cos(x) - 2x^{-3}$ $\quad \frac{2}{x^3} = 2x^{-3}$

$h(x) = f(x) + g(x)$ $\quad h(x) = f(x) - g(x)$

$\Rightarrow h'(x) = f'(x) + g'(x)$ $\quad \Rightarrow h'(x) = f'(x) - g'(x)$

$h(x) = c \cdot f(x)$

$\Rightarrow h'(x) = c \cdot f'(x)$

$f(x) = \frac{1}{2}\ln(x) + \frac{1}{3}x^3 - 2x + 1$

$f'(x) = \frac{1}{2x} + x^2 - 2 + 0$

$f(x)$	Position
$f'(x)$	velocity
$f''(x)$	acceleration
$f'''(x)$	Jerk
$f^{(4)}(x)$	Snap
$f^{(5)}(x)$	Crackle
$f^{(6)}(x)$	Pop

$$f(x) = \frac{1}{2}\ln(x) + \frac{1}{3}x^3 - 2x + 1$$

$$f'(x) = \frac{1}{2x} + x^2 - 2 + 0$$

$$f''(x) \quad \frac{-1}{2x^2} + 2x - 0$$

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

$$-\frac{1}{2}x^{-2}$$

$$f(x) = 5x^4 - \frac{1}{2}x^2 + 3$$

$$f'(x) = 20x^3 - x + 0$$

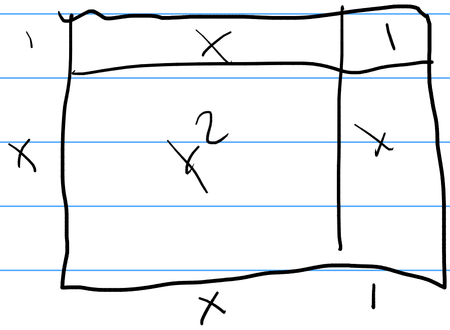
$$f''(x) = 60x^2 - 1$$

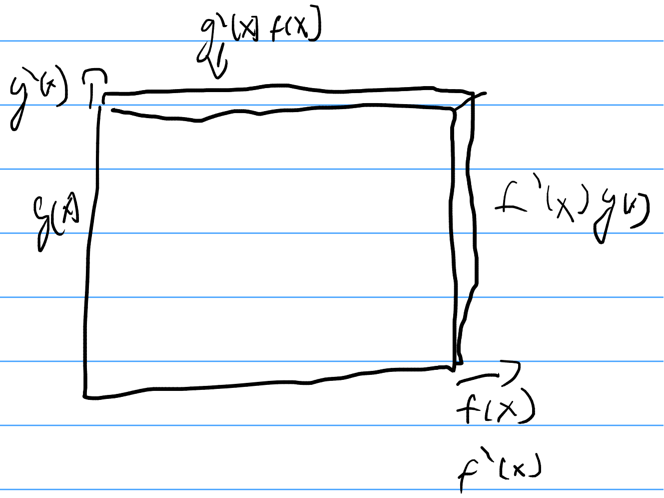
$$f'''(x) = 120x$$

$$f^{(4)}(x) = 120$$

$$f^{(5)}(x) = 0$$

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





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

$f'(x) = 2x \cdot \sin(x) + x^2 \cdot \cos(x)$

$y = \ln(x) \cdot \cos(x)$

$\frac{dy}{dx} = \frac{1}{x} \cdot \cos(x) + \ln(x)(-\sin(x))$

$\frac{\cos(x)}{x} - \ln(x)\sin(x)$

$f(x) = x \ln(x)$

$f'(x) = 1 \cdot \ln(x) + x \cdot \frac{1}{x}$

$= \ln(x) + 1$ when $x \neq 0$

$y = (x^2 + 2x - 3)(4x + 1)$

$\frac{dy}{dx} = (2x+2)(4x+1) + 4(x^2+2x-3)$

$8x^2 + 10x + 2 + 4x^2 + 8x - 12$

$12x^2 + 18x - 10$

$4x^3 + 8x^2 - 12x + x^2 + 2x - 3$

$4x^3 + 9x^2 - 10x - 3$

$12x^2 + 18x - 10$

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

$$\frac{d}{dx} \frac{\sin(x)}{x^2} = \frac{\cos(x) \cdot x^2 - 2x \cdot \sin(x)}{x^4}$$

$$\frac{dy}{dx}$$

$$\tan(x) = \frac{\sin(x)}{\cos(x)}$$

$$s = \frac{o}{h}$$

$$c = \frac{a}{h} \qquad \frac{s}{c} = \frac{o}{a}$$

$$\frac{d}{dx} \tan(x) = \frac{\cos(x) \cdot \cos(x) - (-\sin(x))(\sin(x))}{\cos(x) \cdot \cos(x)}$$

$$\frac{\cos^2(x) + \sin^2(x)}{\cos^2(x)} \qquad \frac{1}{\cos^2(x)}$$

$$\frac{d}{dx} \frac{3x^2 - x}{(x+4)} = \frac{(6x-1)(x+4) - 1 \cdot (3x^2 - x)}{(x+4)^2}$$