Slope of secant line $= \dfrac{f(x+h) - f(x)}{h}$

Function $f(x)$	Derivative $f'(x)$
x^2	$2x$
$5x^2$	$10x$
x^3	$3x^2$
x^4	$4x^3$
$\vdots$	$\vdots$
x^n	nx^{n-1}
$n=-1$: $x^{-1} = \frac{1}{x}$	$-1x^{-2} = -\frac{1}{x^2}$

Power Rule:
The derivative of $f(x) = Cx^n$ is

$$\underbrace{\frac{d}{dx}}_{\text{means "take the derivative of"}} f(x) = Cnx^{n-1}$$

Taking the derivative is preserved by scaling by constants & adding functions

Ex. $\frac{d}{dx}(5x^2) = 10x$

$$\frac{d}{dx}(5x^2 + 2x + 3) = 10x + 2 + 0 = 10x + 2$$

Can check! $\displaystyle \lim_{h\to 0} \frac{\frac{1}{x+h} - \frac{1}{x}}{h} = \lim_{h\to 0} \frac{\frac{x-(x+h)}{(x+h)x}}{h} = \lim_{h\to 0} \frac{-h}{h(x+h)x}$

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

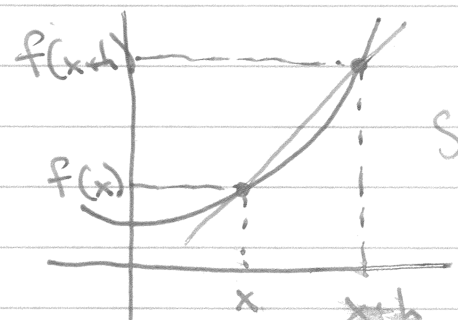
The Product Rule:

Q: If we know $\frac{d}{dx}f(x)$ & $\frac{d}{dx}g(x)$ then do we know

$$\frac{d}{dx}(f(x)\,g(x)) \qquad \text{Ex: } \underline{x}^2 \cdot \underline{\sin(x)}$$

A: Yes $\boxed{\frac{d}{dx}(f(x)g(x)) = f'(x)\cdot g(x) + f(x)\cdot g'(x)}$ Why?

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

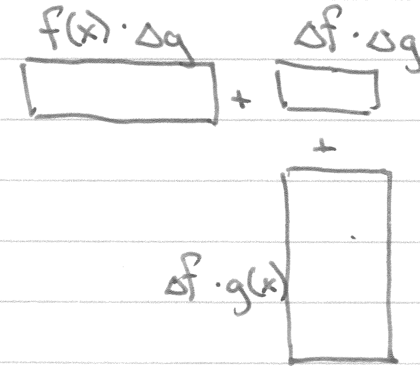


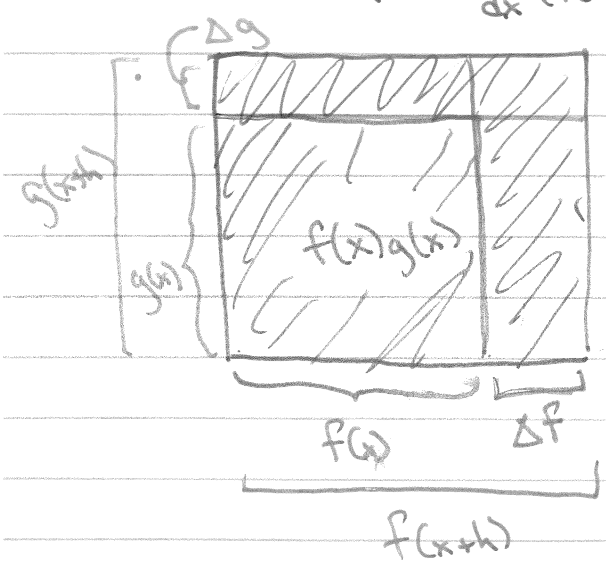
Let $h \to 0$

Slope of secant $= \boxed{\frac{\Delta f}{\Delta x}} = \cdots$

$(h = \Delta x)$

To calculate $\frac{d}{dx}(f(x)g(x))$, need $\Delta(fg) =$





Big box Area $= f(x+h)\,g(x+h)$

As $h \to 0$ $\quad f(x)\cdot\frac{\Delta g}{\Delta x} \to f(x)\,g'(x)$

$\frac{\Delta f}{\Delta x}\cdot g(x) \to f'(x)\cdot g(x)$

$(\Delta f \cdot \Delta g)/\Delta x \to 0$

(Shrinks "like" h^2)