Rules of Differentiation:

Notation:

if $y=f(x)$

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

$\rightarrow \frac{d}{dx}\left(f(x)+g(x)\right)=\frac{df}{dx}+\frac{dg}{dx} \Rightarrow$ Derivative on addition

$\rightarrow \frac{dc}{dx}=0 \Rightarrow$ Derivative of constant is zero

$\rightarrow \frac{d}{dx}\left(f(x)\cdot g(x)\right)=f(x)\frac{dg}{dx}+g(x)\frac{df}{dx} \Rightarrow$ Product rule

$\hookrightarrow$ lets see an example by proving

$$\frac{d}{dx}(x^2)=2x$$

$$\frac{d}{dx}(x^2)=\frac{d}{dx}(x\cdot x)$$

$$=x\frac{d}{dx}(x)+x\frac{d}{dx}(x)$$

$$=x\cdot 1+x\cdot 1=x+x=\underline{\underline{2x}}$$

Chain rule:

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

Eg: $\frac{d\log(x^2)}{dx} \Rightarrow$ Here $f(x)=\log(g(x))$; $g(x)=x^2$

$$=\frac{1}{x^2}\cdot 2x=\underline{\underline{\frac{2}{x}}}$$

Quotient Rule:

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

Eg: $\frac{d}{dx}\left(\frac{\log(x)}{x}\right) \Longrightarrow f(x) = \log(x)\ ;\ g(x) = x$

$$= \frac{(1/x)\cdot(x) - 1\cdot(\log x)}{x^2}$$

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