Theorems for Differentiation.

Let $f(x), g(x)$ and $u(x)$ be differentiable functions

(1) If at all points of a certain interval. $f'(x)=0,$ Then the function $f(x)$ has a constant value within this interval.

(2) **Chain rule**

(i) **Case I:**If y is a function of u and u is a function of x, then derivative of y with respect to x is

$\frac{dy}{dx}=\frac{dy}{du}\frac{du}{dx}$ or $y=f(u) \Rightarrow \frac{dy}{dx}=f'(u)\frac{du}{dx}$

(ii) **Case II:**If y and x both are expressed in terms of t,y and x both are differentiable with respect to t then $\frac{dy}{dx}=\frac{dy/dt}{dx/dt}$.

(3) **Sum and difference rule:**Using linear property $\frac{d}{dx}(f(x) \pm g(x))=\frac{d}{dx}(f(x)) \pm \frac{d}{dx}(g(x))$

(4) **Product rule:**(i) $\frac{d}{dx}(f(x)g(x))=f(x)\frac{d}{dx}g(x)+g(x)\frac{d}{dx}f(x)$ (ii)

$\frac{d}{dx}(u.v.w.)=u.v.\frac{dw}{dx}+v.w.\frac{du}{dx}+u.w.\frac{dv}{dx}$

(5) **Scalar multiple rule:** $\frac{d}{dx}(k\,f(x))=k\frac{d}{dx}f(x)$

(6) **Quotient rule:** $\frac{d}{dx}\left(\frac{f(x)}{g(x)}\right)=\frac{g(x)\frac{d}{dx}(f(x))-f(x)\frac{d}{dx}(g(x))}{(g(x))^2}$, provided $g(x) \neq 0$