$s(t) = \int v(t)\, dt$	**position function**
$s'(t) = v(t) = \int a(t)\, dt$	**velocity function**
$s''(t) = v'(t) = a(t)$	**acceleration function**
$\left\|s(t_1) - s(t_c)\right\| + \left\|s(t_c) - s(t_2)\right\|$	**total distance t_1 to t_2 where t_c = time particle**
definition of definite integral	$\lim\limits_{x \to \infty} \sum\limits_{i=1}^{n} f(c_i)\, \Delta x_i$

$f(x)$ increasing	**$f'(x) > 0$**
$f(x)$ decreasing	**$f'(x) < 0$**
$f(x)$ concave up	**$f''(x) > 0$ or $f'(x)$ increasing**
$f(x)$ concave down	**$f''(x) < 0$ or $f'(x)$ decreasing**

Point of Inflection	**Change in concavity; tangent line exists**
Acceleration function	$s''(t) = v'(t) = a(t)$
Particle at rest	$v(t) = 0$
Particle moving right	$v(t) > 0$
Particle moving left	$v(t) < 0$

Particle changes direction	**$v(t)$ changes sign**
Derivative fails to exist	**1. Corners** **2. Cusps** **3. Vertical Tangents** **4. Discontinuities**
Intermediate Value Theorem for Continuous Functions	**A function $f(x)$ that is continuous on a closed interval (a,b) takes on every value between $f(a)$ and $f(b)$**
Chain Rule $\frac{d}{dx}\left(f(g(x)\right)$	$f'(g(x) \cdot g'(x)$
$\boldsymbol{e}$	$\lim_{x\to 0}(1+x)^{\frac{1}{x}}$ or $\lim_{n\to\infty}\left(1+\frac{1}{n}\right)^n$

Inflection point	$f''(x) = 0$
$f(x)$ **increasing**	$f'(x) > 0$
Derivative of $y = f(x)$	$\lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$
Interpretations of $f'(x)$**:**	1. **Slope of tangent line.** 2. **Instantaneous velocity** 3. **Instantaneous rate of change**
$\lim_{x \to c} \frac{f(x) - f(c)}{x - c}$	**Derivative of** y=(x) **at** (c, $f(c)$)

Rolle's Theorem	**1.** $f(x)$ **is continuous on** $[a,b]$ **2.** $f(x)$ **is differentiable on** (a,b) **3.** $f(a)=f(b)$ **Then there exists** c **in** (a,b) **so** $f'(c) = 0$
Mean Value Theorem	**1.** $f(x)$ **is continuous on** $[a,b]$ **2.** $f(x)$ **is differentiable on** (a,b) **Then there exists** c **in** (a,b) **so** $f'(c) = \frac{f(b) - f(a)}{b - a}$
Extreme Value Theorem	**If a function is continuous on a closed interval, then the function is guaranteed to have an absolute maximum and an absolute minmum.**
Even function	**Symmetrical with respect to the** y**-axis or** $f(-x) = f(x)$
Odd Function	**Symmetrical with respect to the origin or** $f(-x) = -f(x)$

$\frac{d}{dx}(c)$	$\mathbf{0}$
$\frac{d}{dx}(x^n)$	nx^{n-1}
$\frac{d}{dx}(cu)$	$c\frac{du}{dx}$
$\frac{d}{dx}(u \pm v)$	$\frac{du}{dx} \pm \frac{dv}{dx}$
$\frac{d}{dx}(uv)$	$u\frac{dv}{dx} + v\frac{du}{dx}$

$\frac{d}{dx}\left(\frac{u}{v}\right)$	$\frac{v\frac{du}{dx}-u\frac{dv}{dx}}{v^2}$
$\frac{d}{dx}(\sin x)$	$\cos x$
$\frac{d}{dx}(\cos x)$	$-\sin x$
$\frac{d}{dx}(\tan x)$	$\sec^2 x$
$\frac{d}{dx}(\csc x)$	$-\csc x\cot x$

$\dfrac{d}{dx}(\sec x)$	$\sec x \tan x$
$\dfrac{d}{dx}(\cot x)$	$-\csc^2 x$
$\dfrac{d}{dx}(e^u)$	$e^u \dfrac{du}{dx}$
$\dfrac{d}{dx}(a^u)$	$a^u \ln a \dfrac{du}{dx}$
$\dfrac{d}{dx}(\ln u)$	$\dfrac{1}{u}\dfrac{du}{dx}$

$\frac{d}{dx}(\tan^{-1} u)$	$\frac{1}{1+u^2}\frac{du}{dx}$
$\frac{d}{dx}(\cos^{-1} u)$	$-\frac{1}{\sqrt{1-u^2}}\frac{du}{dx}$
$\frac{d}{dx}(\sin^{-1} u)$	$\frac{1}{\sqrt{1-u^2}}\frac{du}{dx}$
$\frac{d}{dx}(\log_a u)$	$\frac{1}{u\ln a}\frac{du}{dx}$
$\lim_{h\to 0}\frac{\sin h}{h}$	1

$\lim_{h \to 0} \frac{\cos h - 1}{h}$	0
$f(x)$ is continuous if:	1. $f(a)$ exists 2. $\lim_{x \to a^+} f(x) = \lim_{x \to a^-} f(x)$ 3. $\lim_{x \to a} f(x) = f(a)$
Critical Point	**A point on the interior of the domain of a function *f* at which *f'*=0 or *f'* does not exist**
First Derivative Test	**1. At a critical point, if *f'* changes from positive to negative, then *f* has a local maximum at *c*.** **2. At a critical point, if *f'* changes from negative, to positive then *f* has a local minimum at *c*.**
Second Derivative Test	**1. If *f'*(*c*) = 0 and *f'*(*c*) <0, then *f* has a local maximum at *x* = *c*.** **2. If *f'*(*c*) = 0 and *f'*(*c*) >0, then *f* has a local minimum at *x* = *c*.**

Newton's Method	$x_{n+1} = x_n - \dfrac{f(x_n)}{f'(x_n)}$
Euler's Method	$y_n = y_{n-1} + f(x_{n-1}, y_{n-1})dx$
Law of Exponential Change	$y = y_O e^{kt}$ $k > 0$ growth $k < 0$ decay
Local Linearization	$L(x) = f(a) + f'(a)(x - a)$
Logistical Differential Equation	$\dfrac{dp}{dt} = \dfrac{k}{m} P(M - P)$ $P = \dfrac{M}{1 + Ae^{-kt}}$

Newton's Law of Cooling	$\frac{dT}{dt} = -k(T - T_S)$ $T - T_S = (T_O - T_S)e^{-kt}$
Half-life	$\frac{\ln 2}{k}$
$\lim_{h\to 0} \frac{\tan h}{h}$	**1**