$\frac{d}{dx}(\sin x) = \cos x$ $\frac{d}{dx}(\cos x) = -\sin x$
$\frac{d}{dx}(\tan x) = \sec^2 x$ $\frac{d}{dx}(\csc x) = \csc x \cot x$
$\frac{d}{dx}(\sec x) = \sec x \tan x$ $\frac{d}{dx}(\cot x) = -\csc^2 x$
$\frac{d}{dx}(\sin^{-1} x) = \frac{1}{\sqrt{1-x^2}}$ $\frac{d}{dx}(\cos^{-1} x) = -\frac{1}{\sqrt{1-x^2}}$
$\frac{d}{dx}(\tan^{-1} x) = \frac{1}{1+x^2}$ $\frac{d}{dx}(\cot^{-1} x) = -\frac{1}{1+x^2}$
$\frac{d}{dx}(\sec^{-1} x) = \frac{1}{x\sqrt{x^2-1}}$ $\frac{d}{dx}(\csc^{-1} x) = -\frac{1}{x\sqrt{x^2-1}}$

Anti-Derivatives to Remember:
$cf(x) \to cF(x)$ / $f(x) + g(x) \to F(x) + G(x)$
$x^n (n \neq -1) \to \frac{x^{n+1}}{n+1}$ / $\frac{1}{x} \to \ln |x|$
$e^x \to e^x$ / $b^x \to \frac{b^x}{\ln b}$
$\cos x \to \sin x$ / $\sin x \to -\cos x$
$\sec^2 x \to \tan x$ / $\sec x \tan x \to \sec x$
$\frac{1}{\sqrt{1-x^2}} \to \sin^{-1} x$ / $\frac{1}{1+x^2} \to \tan^{-1} x$
$\cosh x \to \sinh x$ / $\sinh x \to \cosh x$

Indeterminate Forms:
$\frac{0}{0}$ / $\frac{\infty}{\infty}$
$\frac{-\infty}{-\infty}$ / 0^0
∞^0 / 1^∞ Use logs to convert to a workable form for L'Hospital's Rule

Definition 1. *The area A of the region S that lies under the graph of the continuous function f is the limit of the sum or the areas of approximating rectangles:*

$$A = \lim_{n\to\infty} [f(x-1)\Delta x + f(x_2)\Delta x + f(x_n)\Delta x]$$

Sigma notation or a Riemann sum is read as $\sum_{i=1}^{n} f(x_1)\Delta x = f(x_1 \Delta x + f(x_n \Delta x)$
n is where the ending x-value of the last rectangle
$i = 1$ is where the starting x-value that the rectangle will be

0.1 The Definite Integral

Definition 2. *If f is a function defined for $a \geq x \geq b$, we divide the interval $[a, b]$ into n sub-intervals of equal width $\Delta x = \frac{b-a}{n}$. Letting $x_0 (= a), x_1, x_2, x_n (= b)$ be the endpoints for the sub-intervals, while also letting x_1^*, x_2^*, x_n^* be sample points in each of the subintervals, which means that x_i^* is in the subinterval $[x_{i-1}, x_i]$*
This leads to the definite integral from a to b being $\int_a^b f(x)dx = \lim_{n\to\infty} \sum_{i=1}^{n} f(x_i^* \Delta x)$
THE LIMIT OF THIS FUNCTION MUST EXIST FOR THE ABOVE EQUATION TO WORK

0.1.1 Evaluating Integrals

1. $\sum_{i=1}^{n} i = \frac{n(n+1)}{2}$
2. $\sum_{i=1}^{n} i^2 = \frac{n(n+!)(2n+1)}{6}$
3. $\sum_{i=1}^{n} i^3 = [\frac{n(n+1)}{2}]^2$

Rules for working with Sigma Notation

1. $\sum_{i=1}^{n} c = nc$
2. $\sum_{i=1}^{n} ca_i = c \sum_{i=1}^{n} a_i$
3. $\sum_{i=1}^{n} (a_i + b_i) = \sum_{i=1} na_i + \sum_{i=1} nb_i$
4. $\sum_{i=1}^{n} (a_i - b_i) = \sum_{i=1}^{n} a_i - \sum_{i=1}^{n} b_i$

Since the limit of a Riemann sum works no matter if $a < b$ or $a > b$ we can assume that $\int_b^a f(x)dx = -\int_b^a f(x)dx$
Similar to the derivative rule, if $a = b$ then the change in x(or $\Delta x) = 0$ so the integral evaluates to zero
Here are some of the basic properties of the integral:

1. $\int_b^a cdx = c(b-a)$ when c is a constant
2. $\int_b^a f(x) + g(x)dx = \int_b^a f(x)dx + \int_b^a g(x)dx$
3. $\int_b^a cf(x)dx = c\int_b^a f(x)dx$ when c is a constant
4. $\int_b^a [f(x) - g(x)]dx = \int_b^a f(x)dx - \int_b^a g(x)dx$

0.1.2 The Fundamental Theorem of Calculus

Part 1: If f is continuous on $[a, b]$ then the function g defined by

$$g(x) = \int_a^x f(t)dt \text{ when } a \leq x \leq b$$

As long as the function is continuous along its interval and differentiable along that same interval
Part 2: If f is continuous on $[a, b]$ then:

$$\int_a^b f(x)dx = F(b) - F(a)$$

Meaning that as long as F is any anti derivative of f, $F'(x) = f(x)$