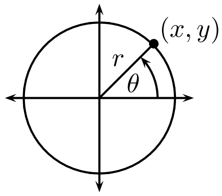
Trigonometric Formulas



$\sin\theta = \frac{y}{r}$
$\cos\theta = \frac{x}{r}$
$\tan\theta = \frac{y}{x}$

Reciporicals

$\cot\theta = \frac{1}{\tan\theta}$ $\quad \sec\theta = \frac{1}{\cos\theta}$ $\quad \csc\theta = \frac{1}{\sin\theta}$

Definitions

$\cot\theta = \frac{\cos\theta}{\sin\theta}$ $\quad \sec\theta = \frac{1}{\cos\theta}$ $\quad \csc\theta = \frac{1}{\sin\theta}$

Hyperbolic

$\sinh\theta = \frac{e^\theta - e^{-\theta}}{2}$ $\quad \cosh\theta = \frac{e^\theta + e^{-\theta}}{2}$ $\quad \tanh\theta = \frac{e^\theta - e^{-\theta}}{e^\theta + e^{-\theta}}$

Pythagorean

$\sin^2\theta + \cos^2\theta = 1$ $\quad \tan^2\theta + 1 = \sec^2\theta$ $\quad 1 + \cot^2\theta = \csc^2\theta$

Cofunction

$\sin(\frac{\pi}{2} - \theta) = \cos\theta$ $\quad \cos(\frac{\pi}{2} - \theta) = \sin\theta$ $\quad \tan(\frac{\pi}{2} - \theta) = \cot\theta$

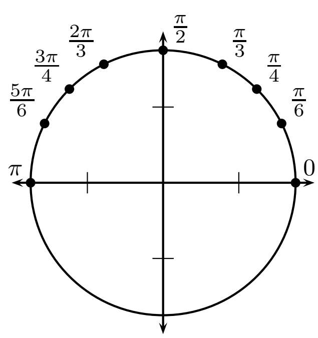
Even/Odd

$\sin -\theta = -\sin\theta$ $\quad \cos -\theta = \cos\theta$ $\quad \tan -\theta = -\tan\theta$

Double Angle

$$\sin 2\theta = 2\sin\theta\cos\theta$$
$$\cos 2\theta = \cos^2\theta - \sin^2\theta$$
$$\cos 2\theta = 1 - 2\sin^2\theta$$

Unit Circle



Half-Angle

$\sin^2\theta = \frac{1-\cos 2\theta}{2}$ $\quad \cos^2\theta = \frac{1+\cos 2\theta}{2}$

Addition

$$\sin(a+b) = \sin a\cos b + \cos a\sin b$$
$$\cos(a+b) = \cos a\cos b - \sin a\sin b$$

Subtraction

$$\sin(a-b) = \sin a\cos b - \cos a\sin b$$
$$\cos(a-b) = \cos a\cos b + \sin a\sin b$$

Sum

$$\sin u + \sin v = 2\sin\frac{u+v}{2}\cos\frac{u-v}{2}$$
$$\cos u + \cos v = 2\cos\frac{u+v}{2}\cos\frac{u-v}{2}$$

Product

$$\sin u\sin v = \frac{1}{2}\left[\cos(u-v) - \cos(u+v)\right]$$
$$\cos u\cos v = \frac{1}{2}\left[\cos(u-v) + \cos(u+v)\right]$$
$$\sin u\cos v = \frac{1}{2}\left[\sin(u+v) + \sin(u-v)\right]$$
$$\cos u\sin v = \frac{1}{2}\left[\sin(u+v) - \sin(u-v)\right]$$

$\sin 0 =$	0	$\cos 0 =$	1
$\sin\frac{\pi}{6} =$	$\frac{1}{2}$	$\cos\frac{\pi}{6} =$	$\frac{\sqrt{3}}{2}$
$\sin\frac{\pi}{4} =$	$\frac{\sqrt{2}}{2}$	$\cos\frac{\pi}{4} =$	$\frac{\sqrt{2}}{2}$
$\sin\frac{\pi}{3} =$	$\frac{\sqrt{3}}{2}$	$\cos\frac{\pi}{3} =$	$\frac{1}{2}$
$\sin\frac{\pi}{2} =$	1	$\cos\frac{\pi}{2} =$	0
$\sin\frac{2\pi}{3} =$	$\frac{\sqrt{3}}{2}$	$\cos\frac{2\pi}{3} =$	$-\frac{1}{2}$
$\sin\frac{3\pi}{4} =$	$\frac{\sqrt{2}}{2}$	$\cos\frac{3\pi}{4} =$	$-\frac{\sqrt{2}}{2}$
$\sin\frac{5\pi}{6} =$	$\frac{1}{2}$	$\cos\frac{5\pi}{6} =$	$-\frac{\sqrt{3}}{2}$
$\sin\pi =$	0	$\cos\pi =$	-1

Derivative Formulas

General Rules

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

Power Rules

$\frac{d}{dx}\, x^r = rx^{r-1}$ $\quad \frac{d}{dx}\, c = 0$ $\quad \frac{d}{dx}\, cx = c$ $\quad \frac{d}{dx}\sqrt{x} = \frac{1}{2\sqrt{x}}$

Exponential Rules

$\frac{d}{dx}\, e^x = e^x$
$\frac{d}{dx}\, e^{u(x)} = e^{u(x)}u'(x)$
$\frac{d}{dx}\, a^x = a^x \ln a$
$\frac{d}{dx}\, e^{rx} = re^{rx}$
$\frac{d}{dx}\ln x = \frac{1}{x}$

Trigonometric Rules

$\frac{d}{dx}\sin x = \cos x$
$\frac{d}{dx}\tan x = \sec^2 x$
$\frac{d}{dx}\sec x = \sec x \tan x$
$\frac{d}{dx}\cos x = -\sin x$
$\frac{d}{dx}\cot x = -\csc^2 x$
$\frac{d}{dx}\csc x = -\csc x \cot x$

Inverse Trigonometric Rules

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

Hyperbolic Rules

$\frac{d}{dx}\sinh x = \cosh x$
$\frac{d}{dx}\tanh x = \mathrm{sech} x$
$\frac{d}{dx}\mathrm{sech} x = -\mathrm{sech} x \tanh x$
$\frac{d}{dx}\cosh x = \sinh x$
$\frac{d}{dx}\coth x = -\mathrm{csch}^2 x$
$\frac{d}{dx}\mathrm{csch} x = -\mathrm{csch} x \coth x$

Inverse Hyperbolic Rules

$\frac{d}{dx}\sinh^{-1} x = \frac{1}{\sqrt{1+x^2}}$
$\frac{d}{dx}\tanh^{-1} x = \frac{1}{1-x^2}$
$\frac{d}{dx}\mathrm{sech}^{-1} x = \frac{-1}{x\sqrt{1-x^2}}$
$\frac{d}{dx}\cosh^{-1} x = \frac{1}{\sqrt{x^2-1}}$
$\frac{d}{dx}\coth^{-1} x = \frac{1}{1-x^2}$
$\frac{d}{dx}\mathrm{csch}^{-1} x = \frac{-1}{|x|\sqrt{x^2+1}}$

Methods

Linear Approximation

The linear approximation of $f(x)$ at $x = x_0$ is

$$L(x) = f(x_0) + f'(x_0)(x - x_0)$$

Newton's Method

$f(x_n) \approx 0$ for

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}, n = 0, 1, 2, 3, ...$$