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Trig Identities

Identities involving trig functions are listed below.

Pythagorean Identities

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

$\tan^2\theta + 1 = \sec^2\theta$

$\cot^2\theta + 1 = \csc^2\theta$

Reciprocal Identities

$$\sin x = \frac{1}{\csc x} \qquad \csc x = \frac{1}{\sin x}$$

$$\cos x = \frac{1}{\sec x} \qquad \sec x = \frac{1}{\cos x}$$

$$\tan x = \frac{1}{\cot x} \qquad \cot x = \frac{1}{\tan x}$$

Ratio Identities

$$\tan x = \frac{\sin x}{\cos x}$$

$$\cot x = \frac{\cos x}{\sin x}$$

Odd/Even Identities

$\sin(-x) = -\sin x$ $\quad \csc(-x) = -\csc x$

$\cos(-x) = \cos x$ $\quad \sec(-x) = \sec x$

$\tan(-x) = -\tan x$ $\quad \cot(-x) = -\cot x$

Cofunction Identities, radians

$$\sin\left(\frac{\pi}{2} - x\right) = \cos x \qquad \cos\left(\frac{\pi}{2} - x\right) = \sin x$$

$$\tan\left(\frac{\pi}{2} - x\right) = \cot x \qquad \cot\left(\frac{\pi}{2} - x\right) = \tan x$$

$$\sec\left(\frac{\pi}{2} - x\right) = \csc x \qquad \csc\left(\frac{\pi}{2} - x\right) = \sec x$$

Cofunction Identities, degrees

$\sin(90° - x) = \cos x$ $\quad \cos(90° - x) = \sin x$

$\tan(90° - x) = \cot x$ $\quad \cot(90° - x) = \tan x$

$\sec(90° - x) = \csc x$ $\quad \csc(90° - x) = \sec x$

Periodicity Identities, radians

$\sin(x + 2\pi) = \sin x$ $\quad \csc(x + 2\pi) = \csc x$

$\cos(x + 2\pi) = \cos x$ $\quad \sec(x + 2\pi) = \sec x$

$\tan(x + \pi) = \tan x$ $\quad \cot(x + \pi) = \cot x$

Periodicity Identities, degrees

$\sin(x + 360°) = \sin x$ $\quad \csc(x + 360°) = \csc x$

$\cos(x + 360°) = \cos x$ $\quad \sec(x + 360°) = \sec x$

$\tan(x + 180°) = \tan x$ $\quad \cot(x + 180°) = \cot x$

Sum/Difference Identities

$$\sin(x+y) = \sin x \cos y + \cos x \sin y$$
$$\sin(x-y) = \sin x \cos y - \cos x \sin y$$

$$\cos(x+y) = \cos x \cos y - \sin x \sin y$$
$$\cos(x-y) = \cos x \cos y + \sin x \sin y$$

$$\tan(x+y) = \frac{\tan x + \tan y}{1 - \tan x \tan y}$$

$$\tan(x-y) = \frac{\tan x - \tan y}{1 + \tan x \tan y}$$

Double Angle Identities

$$\sin 2x = 2 \sin x \cos x$$

$$\cos 2x = \begin{cases} \cos^2 x - \sin^2 x \\ 1 - 2\sin^2 x \\ 2\cos^2 x - 1 \end{cases}$$

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

Half Angle Identities

$$\sin\frac{x}{2}=\pm\sqrt{\frac{1-\cos x}{2}} \quad \text{or} \quad \sin^2 x=\frac{1-\cos 2x}{2}$$

$$\cos\frac{x}{2}=\pm\sqrt{\frac{1+\cos x}{2}} \quad \text{or} \quad \cos^2 x=\frac{1+\cos 2x}{2}$$

$$\tan\frac{x}{2}=\pm\sqrt{\frac{1-\cos x}{1+\cos x}} \quad \text{or} \quad \frac{\sin x}{1+\cos x} \quad \text{or} \quad \frac{1-\cos x}{\sin x}$$

Product to Sum Identities

$$\cos x\cos y=\frac{1}{2}\left[\cos(x+y)+\cos(x-y)\right]$$

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

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

Sum to Product Identities

$$\sin x+\sin y=2\sin\left(\frac{x+y}{2}\right)\cos\left(\frac{x-y}{2}\right)$$

$$\sin x-\sin y=2\cos\left(\frac{x+y}{2}\right)\sin\left(\frac{x-y}{2}\right)$$

$$\cos x+\cos y=2\cos\left(\frac{x+y}{2}\right)\cos\left(\frac{x-y}{2}\right)$$

$$\cos x-\cos y=-2\sin\left(\frac{x+y}{2}\right)\sin\left(\frac{x-y}{2}\right)$$

See also

Sine, cosine, tangent, cosecant, secant, cotangent

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