

Trigonometry Cheat Sheet

Definitions of the Trig Functions

Right triangle definition

For this definition we assume that

$$0 < \theta < \frac{\pi}{2} \text{ or } 0^\circ < \theta < 90^\circ$$



$$\begin{aligned} \sin \theta &= \frac{\text{opposite}}{\text{hypotenuse}} & \csc \theta &= \frac{\text{hypotenuse}}{\text{opposite}} \\ \cos \theta &= \frac{\text{adjacent}}{\text{hypotenuse}} & \sec \theta &= \frac{\text{hypotenuse}}{\text{adjacent}} \\ \tan \theta &= \frac{\text{opposite}}{\text{adjacent}} & \cot \theta &= \frac{\text{adjacent}}{\text{opposite}} \end{aligned}$$

Unit circle definition

For this definition θ is any angle.



$$\begin{aligned} \sin \theta &= \frac{y}{r} & \csc \theta &= \frac{r}{y} \\ \cos \theta &= \frac{x}{r} & \sec \theta &= \frac{r}{x} \\ \tan \theta &= \frac{y}{x} & \cot \theta &= \frac{x}{y} \end{aligned}$$

Domain

The domain is all the values of θ that can be plugged into the functions.

$$\begin{aligned} \sin \theta &: \theta \text{ can be any angle} \\ \csc \theta &: \theta \text{ can be any angle} \\ \cos \theta &: \theta = \left(n + \frac{\pi}{2} \right) \pi, \quad n = 0, \pm 1, \pm 2, \dots \\ \sec \theta &: \theta = n\pi, \quad n = 0, \pm 1, \pm 2, \dots \\ \tan \theta &: \theta = \left(n + \frac{\pi}{2} \right) \pi, \quad n = 0, \pm 1, \pm 2, \dots \\ \cot \theta &: \theta = n\pi, \quad n = 0, \pm 1, \pm 2, \dots \end{aligned}$$

Range

The range is all possible values to get out of the functions.

$$\begin{aligned} -1 &\leq \sin \theta \leq 1 & \csc \theta &\leq -1 \text{ and } \csc \theta \geq 1 \\ -1 &\leq \cos \theta \leq 1 & \sec \theta &\leq -1 \text{ and } \sec \theta \geq 1 \\ -\infty &< \tan \theta < \infty & \cot \theta &< \infty \text{ and } \cot \theta > -\infty \end{aligned}$$

Identities and Properties

Period

The period of a function is the number, P , such that $f(\theta + P) = f(\theta)$. So, θ is a fixed number and P is any angle we have the following periods.

$$\begin{aligned} \sin(\omega\theta) &\rightarrow P = \frac{2\pi}{\omega} \\ \cos(\omega\theta) &\rightarrow P = \frac{2\pi}{\omega} \\ \tan(\omega\theta) &\rightarrow P = \frac{\pi}{\omega} \\ \csc(\omega\theta) &\rightarrow P = \frac{2\pi}{\omega} \\ \sec(\omega\theta) &\rightarrow P = \frac{2\pi}{\omega} \\ \cot(\omega\theta) &\rightarrow P = \frac{\pi}{\omega} \end{aligned}$$

Trigonometric and Co-Function Identities

$$\begin{aligned} \sin \theta &= \frac{\text{opposite}}{\text{hypotenuse}} & \cos \theta &= \frac{\text{adjacent}}{\text{hypotenuse}} \\ \csc \theta &= \frac{\text{hypotenuse}}{\text{opposite}} & \sec \theta &= \frac{\text{hypotenuse}}{\text{adjacent}} \\ \tan \theta &= \frac{\text{opposite}}{\text{adjacent}} & \cot \theta &= \frac{\text{adjacent}}{\text{opposite}} \end{aligned}$$

Pythagorean Identities

$$\begin{aligned} \sin^2 \theta + \cos^2 \theta &= 1 \\ \sec^2 \theta + \tan^2 \theta &= \sec^2 \theta \end{aligned}$$

Even/Odd Formulas

$$\begin{aligned} \sin(-\theta) &= -\sin \theta & \cos(-\theta) &= \cos \theta \\ \csc(-\theta) &= -\csc \theta & \sec(-\theta) &= \sec \theta \\ \tan(-\theta) &= -\tan \theta & \cot(-\theta) &= -\cot \theta \end{aligned}$$

Periodic Formulas

$$\begin{aligned} \sin(\theta + 2\pi n) &= \sin \theta & \cos(\theta + 2\pi n) &= \cos \theta \\ \csc(\theta + 2\pi n) &= \csc \theta & \sec(\theta + 2\pi n) &= \sec \theta \\ \tan(\theta + \pi n) &= \tan \theta & \cot(\theta + \pi n) &= \cot \theta \end{aligned}$$

Double Angle Formulas

$$\begin{aligned} \sin(2\theta) &= 2 \sin \theta \cos \theta \\ \cos(2\theta) &= \cos^2 \theta - \sin^2 \theta \\ &= 2 \cos^2 \theta - 1 \\ &= 1 - 2 \sin^2 \theta \\ \tan(2\theta) &= \frac{2 \tan \theta}{1 - \tan^2 \theta} \end{aligned}$$

Degrees to Radians Formulas

$$\begin{aligned} \theta \text{ is an angle in degrees and } \theta \text{ is an angle in radians then} \\ \frac{\theta}{180} = \frac{\pi}{1} &\rightarrow \theta = \frac{\pi n}{180} \text{ and } n = \frac{180\theta}{\pi} \end{aligned}$$

Formulas and Identities

Half Angle Formulas

$$\begin{aligned} \sin \frac{\theta}{2} &= \pm \sqrt{\frac{1 - \cos \theta}{2}} \\ \cos \frac{\theta}{2} &= \pm \sqrt{\frac{1 + \cos \theta}{2}} \\ \tan \frac{\theta}{2} &= \frac{1 - \cos \theta}{\sin \theta} \end{aligned}$$

Sum and Difference Formulas

$$\begin{aligned} \sin(\alpha \pm \beta) &= \sin \alpha \cos \beta \pm \cos \alpha \sin \beta \\ \cos(\alpha \pm \beta) &= \cos \alpha \cos \beta \mp \sin \alpha \sin \beta \\ \tan(\alpha \pm \beta) &= \frac{\sin \alpha \pm \sin \beta}{\cos \alpha \pm \cos \beta} \end{aligned}$$

Product to Sum Formulas

$$\begin{aligned} \sin \alpha \sin \beta &= \frac{1}{2} [\cos(\alpha - \beta) - \cos(\alpha + \beta)] \\ \cos \alpha \cos \beta &= \frac{1}{2} [\cos(\alpha - \beta) + \cos(\alpha + \beta)] \\ \sin \alpha \cos \beta &= \frac{1}{2} [\sin(\alpha + \beta) + \sin(\alpha - \beta)] \\ \cos \alpha \sin \beta &= \frac{1}{2} [\sin(\alpha + \beta) - \sin(\alpha - \beta)] \end{aligned}$$

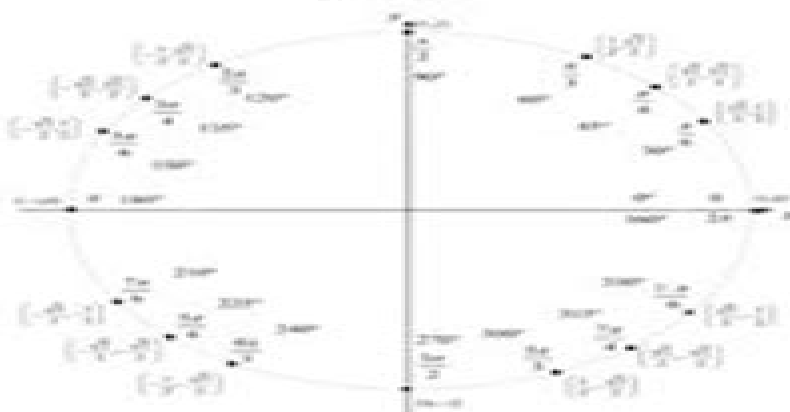
Sum to Product Formulas

$$\begin{aligned} \sin \alpha + \sin \beta &= 2 \sin \left(\frac{\alpha + \beta}{2} \right) \cos \left(\frac{\alpha - \beta}{2} \right) \\ \sin \alpha - \sin \beta &= 2 \cos \left(\frac{\alpha + \beta}{2} \right) \sin \left(\frac{\alpha - \beta}{2} \right) \\ \cos \alpha + \cos \beta &= 2 \cos \left(\frac{\alpha + \beta}{2} \right) \cos \left(\frac{\alpha - \beta}{2} \right) \\ \cos \alpha - \cos \beta &= -2 \sin \left(\frac{\alpha + \beta}{2} \right) \sin \left(\frac{\alpha - \beta}{2} \right) \end{aligned}$$

Co-Function Formulas

$$\begin{aligned} \sin \left(\frac{\pi}{2} - \theta \right) &= \cos \theta & \cos \left(\frac{\pi}{2} - \theta \right) &= \sin \theta \\ \tan \left(\frac{\pi}{2} - \theta \right) &= \cot \theta & \cot \left(\frac{\pi}{2} - \theta \right) &= \tan \theta \\ \csc \left(\frac{\pi}{2} - \theta \right) &= \sec \theta & \sec \left(\frac{\pi}{2} - \theta \right) &= \csc \theta \end{aligned}$$

Unit Circle



For any ordered pair on the unit circle $(x, y) = (\cos \theta, \sin \theta)$

Examples

$$\sin \left(\frac{5\pi}{6} \right) = \frac{1}{2} \quad \cos \left(\frac{5\pi}{6} \right) = -\frac{\sqrt{3}}{2}$$

Reverse Trig Functions

Definition

$$\begin{aligned} y = \sin^{-1} x &\text{ is equivalent to } x = \sin y \\ y = \cos^{-1} x &\text{ is equivalent to } x = \cos y \\ y = \tan^{-1} x &\text{ is equivalent to } x = \tan y \end{aligned}$$

Domain and Range

$$\begin{aligned} y = \sin^{-1} x &\rightarrow -\frac{\pi}{2} \leq y \leq \frac{\pi}{2} \\ y = \cos^{-1} x &\rightarrow 0 \leq y \leq \pi \\ y = \tan^{-1} x &\rightarrow -\frac{\pi}{2} < y < \frac{\pi}{2} \end{aligned}$$

Inverse Properties

$$\begin{aligned} \sin(\sin^{-1} x) &= x & \sin^{-1}(\sin \theta) &= \theta \\ \cos(\cos^{-1} x) &= x & \cos^{-1}(\cos \theta) &= \theta \\ \tan(\tan^{-1} x) &= x & \tan^{-1}(\tan \theta) &= \theta \end{aligned}$$

Adjoint Properties

$$\begin{aligned} \sin^{-1} x &= \arcsin x \\ \cos^{-1} x &= \arccos x \\ \tan^{-1} x &= \arctan x \end{aligned}$$

Law of Sines, Cosines and Tangents



Law of Sines

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

Law of Cosines

$$\begin{aligned} a^2 &= b^2 + c^2 - 2bc \cos A \\ b^2 &= a^2 + c^2 - 2ac \cos B \\ c^2 &= a^2 + b^2 - 2ab \cos C \end{aligned}$$

Half-Angle Formulas

$$\begin{aligned} \sin \frac{\theta}{2} &= \pm \sqrt{\frac{1 - \cos \theta}{2}} \\ \cos \frac{\theta}{2} &= \pm \sqrt{\frac{1 + \cos \theta}{2}} \end{aligned}$$

Law of Tangents

$$\begin{aligned} \frac{a-b}{a+b} &= \frac{\tan \left(\frac{A-B}{2} \right)}{\tan \left(\frac{A+B}{2} \right)} \\ \frac{b-c}{b+c} &= \frac{\tan \left(\frac{B-C}{2} \right)}{\tan \left(\frac{B+C}{2} \right)} \\ \frac{c-a}{c+a} &= \frac{\tan \left(\frac{C-A}{2} \right)}{\tan \left(\frac{C+A}{2} \right)} \end{aligned}$$

Trigonometry Cheat Sheet Year 11

S Ben Porath



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