

# Trigonometry Law and Identities

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## Six Trigonometric Functions

$$\begin{aligned} \sin \theta &= \frac{\text{opp}}{\text{hyp}} & \csc \theta &= \frac{\text{hyp}}{\text{opp}} \\ \cos \theta &= \frac{\text{adj}}{\text{hyp}} & \sec \theta &= \frac{\text{hyp}}{\text{adj}} \\ \tan \theta &= \frac{\text{opp}}{\text{adj}} & \cot \theta &= \frac{\text{adj}}{\text{opp}} \end{aligned}$$

## Reciprocal Functions

$$\begin{aligned} \sin \theta &= \frac{1}{\csc \theta} & \csc \theta &= \frac{1}{\sin \theta} \\ \cos \theta &= \frac{1}{\sec \theta} & \sec \theta &= \frac{1}{\cos \theta} \\ \tan \theta &= \frac{1}{\cot \theta} & \cot \theta &= \frac{1}{\tan \theta} \end{aligned}$$

## Pythagorean Identities

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

## Half Angle Identities

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

## Even/Odd Identities

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

## Double Angle Identities

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

## Sum and Difference Identities

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

## Cofunction Identities

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

## Sum to Product Identities

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

## Product to Sum Identities

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

## Power-Reducing Formulas

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

## Law of Sines

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

## Tangent Identities

$$\begin{aligned} \tan \theta &= \frac{\sin \theta}{\cos \theta} \\ \cot \theta &= \frac{\cos \theta}{\sin \theta} \end{aligned}$$

## Quotient Identities

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

## Law of Cosines

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



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