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# TRIGONOMETRY MASTER CHEAT SHEET

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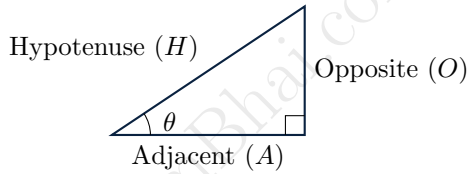
## 1. Basic Definitions & Ratios

For a right-angled triangle with angle $\theta$, Opposite ($O$), Adjacent ($A$), and Hypotenuse ($H$):




$$\sin\theta = \frac{O}{H}, \quad \cos\theta = \frac{A}{H}, \quad \tan\theta = \frac{O}{A}$$
$$\csc\theta = \frac{H}{O}, \quad \sec\theta = \frac{H}{A}, \quad \cot\theta = \frac{A}{O}$$
$$\tan\theta = \frac{\sin\theta}{\cos\theta}, \quad \cot\theta = \frac{\cos\theta}{\sin\theta}$$

## 2. Fundamental Pythagorean Identities

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

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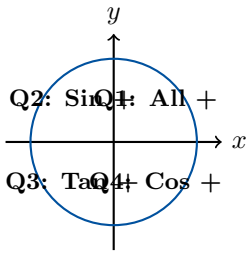
## 3. Unit Circle & Quadrants




**ASTC Rule:** ***A**ll **S**ilver **T**ea **C**ups*

## 4. Standard Angle Values

| $\theta$ | **0°** | **30°** | **45°** | **60°** | **90°** |
|---|---|---|---|---|---|
| Rad | 0 | $\frac{\pi}{6}$ | $\frac{\pi}{4}$ | $\frac{\pi}{3}$ | $\frac{\pi}{2}$ |
| $\sin\theta$ | 0 | $\frac{1}{2}$ | $\frac{1}{\sqrt{2}}$ | $\frac{\sqrt{3}}{2}$ | 1 |
| $\cos\theta$ | 1 | $\frac{\sqrt{3}}{2}$ | $\frac{1}{\sqrt{2}}$ | $\frac{1}{2}$ | 0 |
| $\tan\theta$ | 0 | $\frac{1}{\sqrt{3}}$ | 1 | $\sqrt{3}$ | $\infty$ |

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## 5. Compound Angle Formulas

$$\sin(A \pm B) = \sin A \cos B \pm \cos A \sin B$$

$$\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$$

$$\tan(A \pm B) = \frac{\tan A \pm \tan B}{1 \mp \tan A \tan B}$$

$$\cot(A \pm B) = \frac{\cot A \cot B \mp 1}{\cot B \pm \cot A}$$

## 6. Double & Triple Angle Formulas

**Double Angle**

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

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

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

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

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### Triple Angle

$$\sin 3\theta = 3\sin\theta - 4\sin^3\theta$$

$$\cos 3\theta = 4\cos^3\theta - 3\cos\theta$$

$$\tan 3\theta = \frac{3\tan\theta - \tan^3\theta}{1 - 3\tan^2\theta}$$

### Half Angle Identities

$$\sin^2(\frac{\theta}{2}) = \frac{1-\cos\theta}{2}$$

$$\cos^2(\frac{\theta}{2}) = \frac{1+\cos\theta}{2}$$

$$\tan(\frac{\theta}{2}) = \frac{1-\cos\theta}{\sin\theta} = \frac{\sin\theta}{1+\cos\theta}$$

## 7. Product to Sum & Sum to Product

### Product to Sum

$$2\sin A\cos B = \sin(A+B) + \sin(A-B)$$

$$2\cos A\sin B = \sin(A+B) - \sin(A-B)$$

$$2\cos A\cos B = \cos(A+B) + \cos(A-B)$$

$$2\sin A\sin B = \cos(A-B) - \cos(A+B)$$

### Sum to Product

$$\sin C + \sin D = 2\sin(\frac{C+D}{2})\cos(\frac{C-D}{2})$$

$$\sin C - \sin D = 2\cos(\frac{C+D}{2})\sin(\frac{C-D}{2})$$

$$\cos C + \cos D = 2\cos(\frac{C+D}{2})\cos(\frac{C-D}{2})$$

$$\cos C - \cos D = -2\sin(\frac{C+D}{2})\sin(\frac{C-D}{2})$$

## 8. Triangle Rules (Non-Right Triangle)

For triangle $ABC$ with sides $a, b, c$ opposite to angles $A, B, C$:

### Law of Sines

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C} = 2R$$

*(where $R$ is the circumradius)*

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### Law of Cosines

$$a^2 = b^2 + c^2 - 2bc\cos A$$
$$b^2 = a^2 + c^2 - 2ac\cos B$$
$$c^2 = a^2 + b^2 - 2ab\cos C$$

### Law of Tangents

$$\frac{a-b}{a+b} = \frac{\tan(\frac{A-B}{2})}{\tan(\frac{A+B}{2})}$$

### Area of Triangle ($\Delta$)

$$\text{Area} = \frac{1}{2}ab\sin C = \frac{1}{2}bc\sin A = \frac{1}{2}ac\sin B$$
$$\text{Heron's Formula: } \Delta = \sqrt{s(s-a)(s-b)(s-c)}$$
$$\text{where } s = \frac{a+b+c}{2}$$

## 9. Inverse Trigonometric Functions

### Domain & Principal Range

| Func | Domain | Principal Range |
|---|---|---|
| $\sin^{-1} x$ | $[-1, 1]$ | $[-\pi/2, \pi/2]$ |
| $\cos^{-1} x$ | $[-1, 1]$ | $[0, \pi]$ |
| $\tan^{-1} x$ | $\mathbb{R}$ | $(-\pi/2, \pi/2)$ |

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### Key Inverse Properties

$$\sin^{-1}(-x) = -\sin^{-1} x, \quad \cos^{-1}(-x) = \pi - \cos^{-1} x$$
$$\sin^{-1} x + \cos^{-1} x = \frac{\pi}{2}$$
$$\tan^{-1} x + \cot^{-1} x = \frac{\pi}{2}$$
$$\tan^{-1} x + \tan^{-1} y = \tan^{-1}(\frac{x+y}{1-xy}) \quad (xy < 1)$$

## 10. Trigonometric Equations

General solutions for integer $n \in \mathbb{Z}$:

$$\sin\theta = \sin\alpha \implies \theta = n\pi + (-1)^n\alpha$$
$$\cos\theta = \cos\alpha \implies \theta = 2n\pi \pm \alpha$$
$$\tan\theta = \tan\alpha \implies \theta = n\pi + \alpha$$
$$\sin^2\theta = \sin^2\alpha \implies \theta = n\pi \pm \alpha$$

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