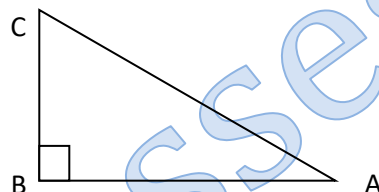


# Trigonometry

## Trigonometrical Ratios

There are 6 trigonometrical ratios relating to the three sides of a right-angled triangle.

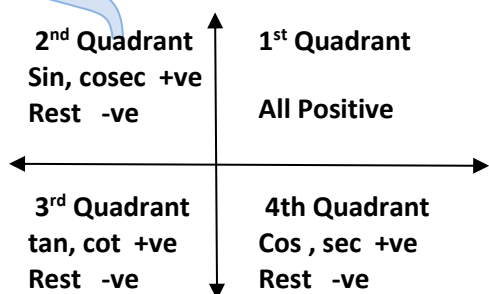


1. Sine (sin) =  $\frac{\text{Perpendicular}}{\text{Hypotenuse}} \Rightarrow \sin A = \frac{BC}{AC}$  &  $\sin C = \frac{AB}{AC}$
2. Cosine (Cos) =  $\frac{\text{Base}}{\text{Hypotenuse}} \Rightarrow \cos A = \frac{AB}{AC}$  &  $\cos C = \frac{BC}{AC}$
3. Tangent (tan) =  $\frac{\text{Perpendicular}}{\text{Base}} \Rightarrow \tan A = \frac{BC}{AB}$  &  $\tan C = \frac{AB}{BC}$
4. Cotangent (cot) =  $\frac{\text{Base}}{\text{Perpendicular}} \Rightarrow \cot A = \frac{AB}{BC}$  &  $\cot C = \frac{BC}{AB}$
5. Secant (sec) =  $\frac{\text{Hypotenuse}}{\text{Base}} \Rightarrow \sec A = \frac{AC}{AB}$  &  $\sec C = \frac{AC}{BC}$
6. Cosecant (cosec) =  $\frac{\text{Hypotenuse}}{\text{Perpendicular}} \Rightarrow \text{cosec } A = \frac{AC}{BC}$  &  $\text{cosec } C = \frac{AC}{AB}$

## Relations between different Trigonometrical Ratios

1.  $\sin A = \frac{1}{\text{cosec } A} \Rightarrow \sin A * \text{cosec } A = 1 \Rightarrow \text{cosec } A = \frac{1}{\sin A}$
2.  $\cos A = \frac{1}{\sec A} \Rightarrow \cos A * \sec A = 1 \Rightarrow \sec A = \frac{1}{\cos A}$
3.  $\tan A = \frac{1}{\cot A} \Rightarrow \tan A * \cot A = 1 \Rightarrow \cot A = \frac{1}{\tan A}$
4.  $\tan A = \frac{\sin A}{\cos A}$
5.  $\cot A = \frac{\cos A}{\sin A}$

## Signs of the Trigonometric Ratios



## Trigonometric Ratios of (-A)

$$\begin{aligned} \sin(-A) &= -\sin A & \cos(-A) &= \cos A & \tan(-A) &= -\tan A \\ \text{cosec } (-A) &= -\text{cosec } A & \sec(-A) &= \sec A & \cot(-A) &= -\cot A \end{aligned}$$

### Even Function

If  $f(-x) = f(x)$  for all  $x$  in its domain.

### Odd Function

If  $f(-x) = -f(x)$  for all  $x$  in its domain.

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	0	$\pi/6$	$\pi/4$	$\pi/3$	$\pi/2$	$\pi$
sin	0	1/2	$1/\sqrt{2}$	$\sqrt{3}/2$	1	0
cos	1	$\sqrt{3}/2$	$1/\sqrt{2}$	1/2	0	-1
tan	0	$1/\sqrt{3}$	1	$\sqrt{3}$	$\infty$	0
cot	$\infty$	$\sqrt{3}$	1	$1/\sqrt{3}$	0	$\infty$
sec	1	$2/\sqrt{3}$	$\sqrt{2}$	2	$\infty$	-1
cosec	$\infty$	2	$\sqrt{2}$	$2/\sqrt{3}$	1	$\infty$

## Square Relation

$$1. \sin^2 A + \cos^2 A = 1 \quad 2. \sec^2 A - \tan^2 A = 1 \quad 3. \operatorname{cosec}^2 A - \cot^2 A = 1$$

## Trigonometric ratios of sum and difference of two angles

$$\begin{array}{l} \sin(A+B) = \sin A \cos B + \cos A \sin B \\ \sin(A-B) = \sin A \cos B - \cos A \sin B \\ \cos(A+B) = \cos A \cos B - \sin A \sin B \\ \cos(A-B) = \cos A \cos B + \sin A \sin B \end{array} \left| \begin{array}{l} \tan(A+B) = \frac{\tan A + \tan B}{1 - \tan A \tan B} \\ \tan(A-B) = \frac{\tan A - \tan B}{1 + \tan A \tan B} \end{array} \right. \left| \begin{array}{l} \cot(A+B) = \frac{\cot A \cot B - 1}{\cot B + \cot A} \\ \cot(A-B) = \frac{\cot A \cot B + 1}{\cot B - \cot A} \end{array} \right.$$

$$\begin{array}{l} 2\sin A \cos B = \sin(A+B) + \sin(A-B) \\ 2\cos A \sin B = \sin(A+B) - \sin(A-B) \end{array} \left| \begin{array}{l} 2\cos A \cos B = \cos(A+B) + \cos(A-B) \\ 2\sin A \sin B = \cos(A-B) - \cos(A+B) \end{array} \right.$$

$$\begin{array}{l} \sin C + \sin D = 2\sin \frac{C+D}{2} \cos \frac{C-D}{2} \\ \sin C - \sin D = 2\sin \frac{C-D}{2} \cos \frac{C+D}{2} \end{array} \left| \begin{array}{l} \cos C + \cos D = 2\cos \frac{C+D}{2} \cos \frac{C-D}{2} \\ \cos C - \cos D = -2\sin \frac{C+D}{2} \sin \frac{C-D}{2} \end{array} \right.$$

## Trigonometric Ratios of Angle 2A in terms of Angle A

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

## Trigonometric Ratios of Angle 3A in terms of Angle A

$$\sin 3A = 3\sin A - 4\sin^3 A \quad \cos 3A = 4\cos^3 A - 3\cos A \quad \tan 3A = \frac{3\tan A - \tan^3 A}{1 - 3\tan^2 A}$$