Tan 90°: Definition, Value & Real-World Applications

Discover the value, derivation, and real-world applications of Tan 90° in physics, engineering, and daily life. Learn how to solve problems step-by-step.

Introduction

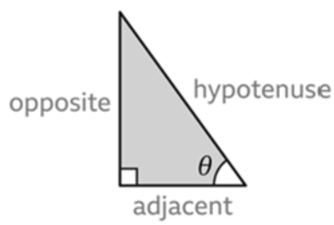
Imagine a rocket taking off from the ground vertically. The angle between the rocket and the ground approaches to 90° as it rises. In trigonometry and scientific applications, it is essential to understand the tangent function at this angle.

In this article, we'll explore:

- What is Tan 90°?
- What is the value of Tan 90°?
- Where is Tan 90°applied in real life?

Tangent

Tangent, written as tan, is a fundamental trigonometric function that represents the ratio of the opposite side to the adjacent side in a right-angled triangle. Mathematically, for any angle θ in a right triangle:



$$Tan\ \theta = \frac{Sin\ \theta}{Cos\ \theta} = \frac{Opposite\ side}{Adjacent\ side}$$

What is Tan 90°?

The value of the tangent trigonometric function for an angle of 90° between the opposite side and the adjacent side is known as Tangent 90 degree. The formal notation for the tangent of a ninety-degree angle is tan 90°.

Value of Tan 90°

The value of tan 90° is undefined. This is because, in a right-angled triangle, when the angle reaches 90°, the adjacent side becomes zero. Since division by zero is not defined, tan 90° is considered undefined.

$$Tan\ 90° = \frac{Opposite\ side}{0} = Undefined$$

Thus, tan 90° does not have a finite value.

Value of Tan 90° in radians

We know that

θ in radians = $\frac{\pi}{180°} \times \theta$ in degrees

$= 90° \times \left(\frac{\pi}{180°}\right)$

$= \frac{1}{2} \times \pi = \frac{\pi}{2}$

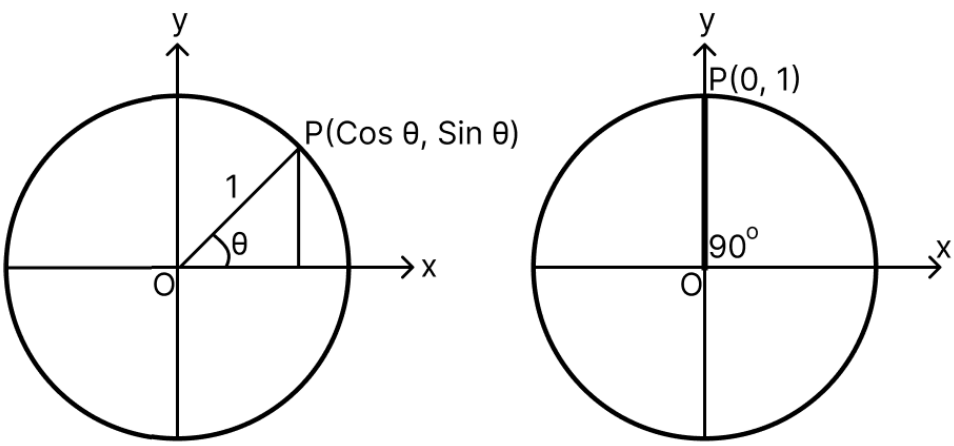
$Tan\ 90° = Tan\ \frac{\pi}{2} = not\ defined$

Value of Tan 90° using a unit circle

On a unit circle, the hypotenuse is always 1 since the radius of the unit circle is 1. We know that

$Cos\ \theta = \frac{Adjacent\ side}{hypotenuse}$

Since the hypotenuse is equal to 1, cos θ = adjacent side of the right-angled triangle, i.e., x- coordinate of point P. Similarly, y-coordinate of point P will be Sin θ.



As θ approaches $90°$, y-coordinate, i.e, $\sin\theta$ becomes 1 and x-coordinate, i.e., cos θ becomes 0. The value of $Cos\ 90° = 0$ and $Sin\ 90° = 1$. Therefore, the value of $Tan\ 90° = \frac{sin\theta}{\cos\theta} = \frac{1}{0} = Not\ defined$.

Value of Tan 90° using trigonometric identities

Tan 90° can be represented using trigonometric identities as follows:

- $\frac{\sin(90°)}{\cos(90°)}$
- $\frac{\sin 90°}{\sqrt{1-\sin^2 90°}}$
- $\frac{\sqrt{1-\cos^2 90°}}{\cos 90°}$
- $\frac{1}{\sqrt{Cosec^2 90°-1}}$
- $\sqrt{Sec^2 90° - 1}$
- $\frac{1}{\cot 90°}$

Examples to Make It Easy

Example 1: Find the value of $\tan\ 90° + \cot\ 90°$

Solution: $\tan\ 90° + \cot\ 90° =$ Undefined $+0 =$ Undefined

Example 2: Solve $\tan^2\ 90° - \sec^2\ 90°$.

Solution: Since $\tan\ 90°$ and $\sec\ 90°$ are undefined, the expression remains undefined.

Example 3: A vertical flagpole casts no shadow at noon. What is the angle of elevation of the sun, and how does it relate to $\tan\ 90°$?

Solution: At noon, the sun is directly overhead, making the angle of elevation 90°. The tangent function at this angle is undefined because the shadow (adjacent side) is zero.

Practice Questions

Test yourself with these problems:

1. Using the identity $1 + \tan^2\ \theta = \sec^2\ \theta$, explain why $\tan\ 90°$ is undefined.
2. Find $\tan\ 90° \times \cot\ 90°$.
3. A rocket launches vertically. What is the angle between the rocket's path and the ground?

Real-Life Applications of tan 90°:

1. **Rocket Launches:** When a rocket takes off vertically, its path makes a 90° angle with the ground.
2. **Architecture:** The concept of verticality in buildings relies on perpendicular angles (90°) for stability.
3. **Sun Elevation:** At solar noon, the sun is directly overhead, forming a 90° angle with the ground.
4. **Surveying:** Theodolites measure vertical angles, including 90°, for height and distance calculations.

5. **Physics of Free Fall:** When an object falls straight down, it moves at an angle of 90° relative to the ground.

Conclusion

Tan 90° is a unique trigonometric function that remains undefined because it involves division by zero. While it doesn't have a finite value, its concept is fundamental in physics, engineering, and everyday scenarios. Understanding tan 90° helps solve practical problems in motion analysis, surveying, and architecture.

Frequently asked questions (FAQs)

Q1. How much does tan 90° mean?
Since it involves division by zero, tan 90° is undefinable.

Q2. What makes tan 90° ambiguous?
Since the adjacent side of a right triangle becomes zero at 90 degrees, the triangle is undefined.

Q3. What is the practical application of tan 90°?
It is employed in the construction of constructions, rocket launches, and vertical height calculations.

Q4. Does the radian value of tan 90° change?
No, tan 90° is still undefined and is the same as $\tan(\frac{\pi}{2})$.

Q5. What is tan 90°'s reciprocal?
Tan 90° has a reciprocal of cot 90°, or 0.