2025Q1 BASIC TRIGONOMETRY

Welcome back, class! This week, we're tackling trigonometry and learning how it applies to real-world questions about height and distance.

Have you ever looked up at a towering building and wondered how high it was? Or stood at the edge of a field and wondered how far it stretches? If you don't have a tape measure long enough to find out, trigonometry is here to help! The foundation of trigonometry lies in three critical functions that can help you measure heights and distances with ease.

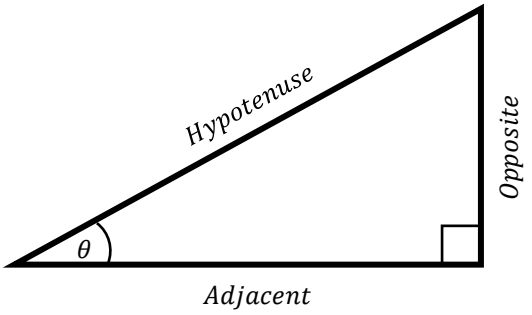
- **Sine (Sin)**: The ratio of the opposite side to the hypotenuse.
- **Cosine (Cos)**: The ratio of the adjacent side to the hypotenuse.
- **Tangent (Tan)**: The ratio of the opposite side to the adjacent side.

One way you can remember this is with the mnemonic device "SOHCAHTOA":

SOH ***CAH*** ***TOA***

$$Sin(\theta) = \frac{Opposite}{Hypotenuse} \quad Cos(\theta) = \frac{Adjacent}{Hypotenuse} \quad Tan(\theta) = \frac{Opposite}{Adjacent}$$

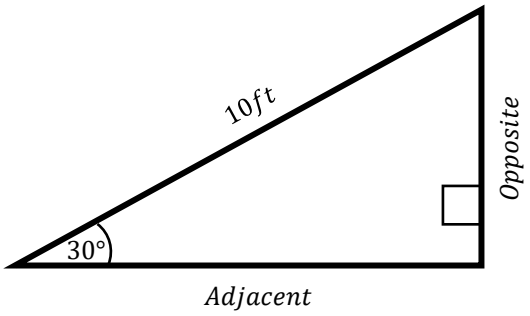
You might be wondering what the *opposite, adjacent, and hypotenuse* sides are. They are simply the sides of a right triangle based on an angle inside the triangle called **theta (*θ*).** Look at the diagram below to where each side is located.



Based on theta's position, the opposite side is the one directly across from theta, and the adjacent side is the one right next to it. The hypotenuse is always the longest side of the right triangle.

2025Q1 BASIC TRIGONOMETRY

Trigonometry helps us understand the relationships between the sides of the triangle. You can use trigonometric functions ($Sin, Cos, \& Tan$) to find missing sides of a triangle. For example, if we know theta and the hypotenuse, we can use Sin and Cos to calculate the missing sides.



$$Sin(\theta) = \frac{Opposite}{Hypotenuse} \qquad Cos(\theta) = \frac{Adjacent}{Hypotenuse}$$

$$Sin(30°) = \frac{Opposite}{10ft} \qquad Cos(30°) = \frac{Adjacent}{10ft}$$

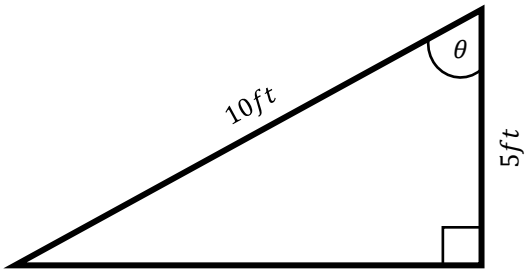
$$10ft \times Sin(30°) = Opposite \qquad 10ft \times Cos(30°) = Adjacent$$

$$\mathbf{5ft = Opposite} \qquad \mathbf{8.7ft = Adjacent}$$

Example 1

But what if you don't have an angle? You can use the inverse functions which are: Sin^{-1}, Cos^{-1}, & Tan^{-1}

$$Sin^{-1}\left(\frac{Opposite}{Hypotenuse}\right) = \theta \qquad Cos^{-1}\left(\frac{Adjacent}{Hypotenuse}\right) = \theta \qquad Tan^{-1}\left(\frac{Opposite}{Adjacent}\right) = \theta$$



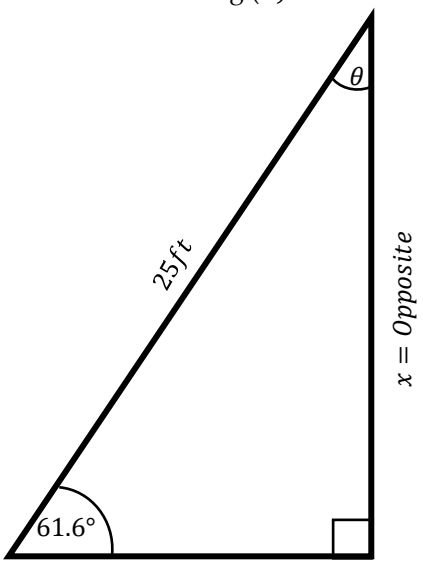
$$Cos^{-1}\left(\frac{Adjacent}{Hypotenuse}\right) = \theta$$

$$Cos^{-1}\left(\frac{5ft}{10ft}\right) = \theta$$

$$\mathbf{60° = \theta}$$

Example 2

Practice problem: a 25-foot ladder is leaning up against the top edge of a 2-story building, the angle the ladder makes with the ground is 61.6 degrees. How tall is the building and what angle is the ladder making with the building ($\boldsymbol{\theta}$)?



$$Sin(\theta) = \frac{Opposite}{Hypotenuse}$$

$$Sin(61.6°) = \frac{Opposite}{25ft}$$

$$25ft \times Sin(61.6°) = Opposite$$

$$\mathbf{22ft = Opposite}$$

$$Cos^{-1}\left(\frac{Adjacent}{Hypotenuse}\right) = \theta$$

$$Cos^{-1}\left(\frac{22ft}{25ft}\right) = \theta$$

$$\mathbf{28.4° = \theta}$$

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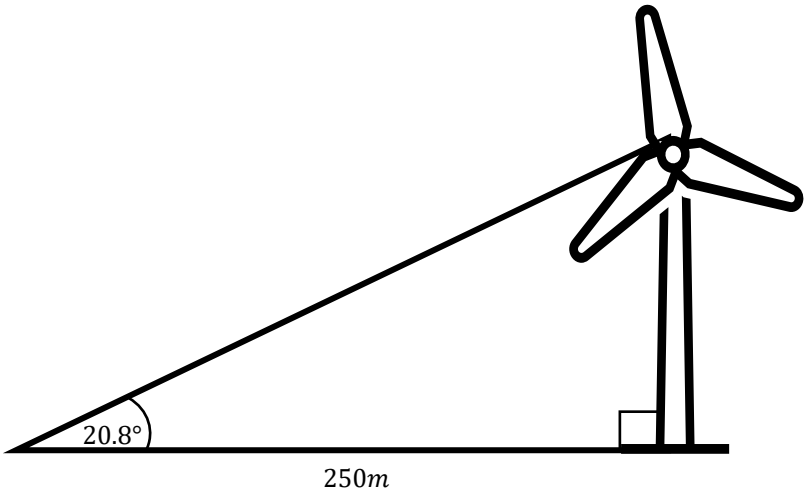
Level 1: You walk 250 meters away from a wind turbine. Using a sextant, you figure out that the angle from the ground to the top of the turbine's hub is 20.8 degrees. How tall is the wind turbine?

Hint: Use SOH CAH TOA to find which trig function you should use.



Level 2: There are two turbines in a field. You are standing 250 meters away from one, and you know that the distance between the two is 180 meters; what is the angle between the two?

Hint: You are trying to find the angle, use the correct trig function.