# Trigonometry

Soh Cah Toa!!!!

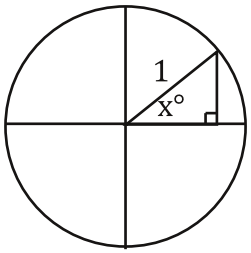
Huh? We'll get back to that... First, what the heck is Trigonometry? Why, the very mention of it is enough to make prospective students run away in terror, as if Godzilla would make a nice pet compared to the terror of Trig. Actually, Trigonometry (Trig for short) comes from the Greek "Trigon" which means triangle and "metry" which means the measure of something. So we get "to measure a triangle". Hey, we've done a lot of that already... in this case we are talking about right triangles. Let's look at this...

What if you have a right triangle and you know one angle (besides the right angle) and one side length. Could you find all the other angles and sides? Well the angles yes, but the other sides, no... not so far. Trig is a set of tools for doing just that. What if we know two sides but no angles? Can we find all the angles? Trig can help with that too. In fact, Trigonometry is a particularly powerful tool. Every map and every building and all kinds of video, navigation and science concepts use trigonometry. Ever see those guys that stand in the middle of road looking through some sort of camera thing? Those are surveyors, and they map the landscape and draw property lines and all sorts of things. They use trig all the time. (And they make pretty good money too!)

Let's look at the tools, shall we?

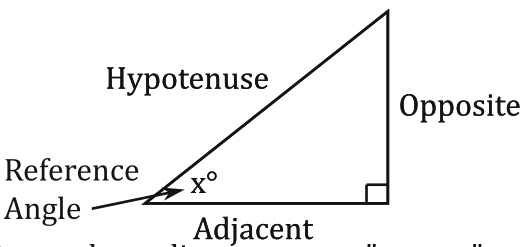
Sine, Cosine and Tangent. All you have to know about trig is those three words. What are they?

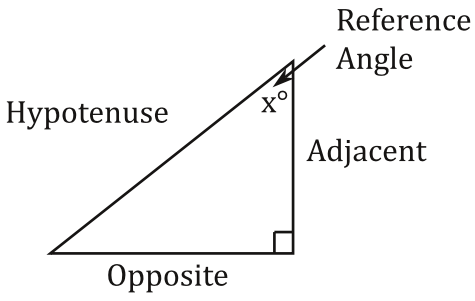
If you take a right triangle and draw it on the x axis inside a triangle with a radius of 1 (This is called the unit circle.), then Sine, Cosine, and Tangent tell you how long the other sides of the triangle are, given a value for the angle labeled x.




You don't really need to know this, but it helps to know where things come from. Here are the things you need to know. (and tattoo on your brain.... figuratively of course.)

If you have a right triangle and some angle x, this angle is called the Reference Angle. From that angle, you have the opposite side, the adjacent side, and of course, the hypotenuse (a, o and h for short). If that angle changes position as in figure 2, then the adjacent and opposite flip.

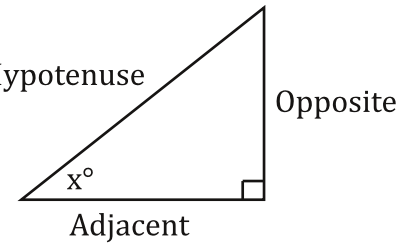



Remember, adjacent means "next to" so it is next to the reference angle. Opposite is always across from the reference angle, and the hypotenuse is always opposite the right angle.

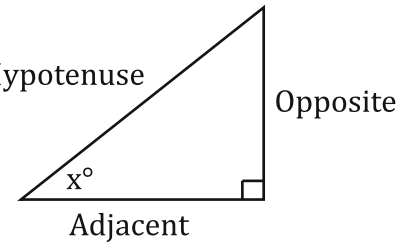
The Sine ratio is defined as the Opposite over the Hypotenuse (abbreviated Sin).

$$\text{Sin } x° = \frac{\text{Opposite}}{\text{Hypotenuse}}$$



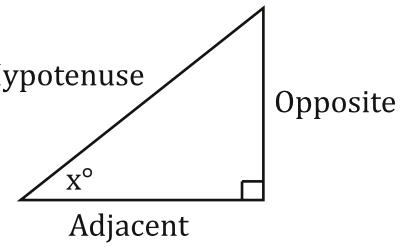

The Cosine ratio is defined as the Adjacent over the Hypotenuse. (Abbreviated Cos)

$$\text{Cos } x° = \frac{\text{Adjacent}}{\text{Hypotenuse}}$$




The Tangent ratio is defined as the Opposite over the Adjacent. (Abbreviated Tan)

$$\text{Tan } x° = \frac{\text{Opposite}}{\text{Adjacent}}$$

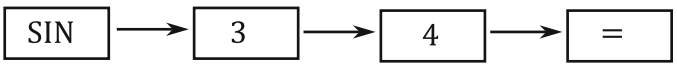



Memorize these! How? Sine is opposite of hypotenuse (Soh). Cosine is adjacent over hypotenuse (Cah), and Tangent is opposite over adjacent (Toa). So, if you memorize "Soh Cah Toa," you have all three! (Oh, so that's what that means....)

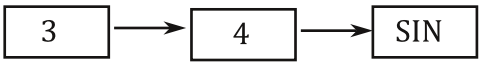
SOLVING FOR MISSING SIDES OF RIGHT TRIANGLES.

First we must know how to use our calculators.

To calculate the value of Sin 34° on most calculators (algebraic entry) press:



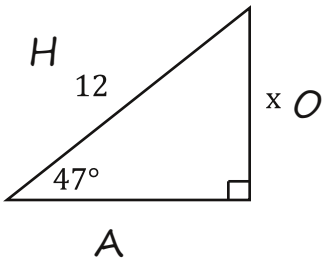

If this doesn't work or gives you an error then you have a standard entry calculator press:




If this is still giving you wrong answers make sure your calculator says "DEG" somewhere on the screen. If it says "RAD", "GRAD," or something else, change it to "DEG." If you don't know how to do this consult the manual or ask someone. Here are some to practice. Round to 4 decimal places!

Tan 51°= Cos 73°= Sin 18°= Cos 35°= Tan 45°=

To actually solve now... look at this triangle below after you label all the sides "O", "A" and "H"... What ratio do you think you would need?




...that's right, the Sine ratio! Why? Because you have the hypotenuse, and you are looking for the opposite. The only one that contains both the opposite and the hypotenuse is "Soh," so.... Sine.

Now plug in the numbers and solve for x. Make sure to leave the calculator bit for the very end. It will be more accurate this way!

$\text{Sin } 47° = \frac{O}{H}$

$\text{Sin } 47° = \frac{x}{12}$

$12 * \text{Sin } 47° = \frac{x}{12} * 12$

$12(\sin 47°) = x$

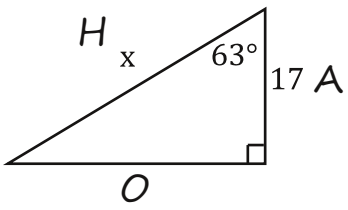
$12(0.7314) = x$ Round this step to 4 decimals.

$8.78 \approx x$ Round your answer to 2 decimals.

This means approximately equal.
(Because of the rounding...)

Here are more examples...

Step 1. Label the sides




Step 2. Choose the ratio and write it out.

$\cos 63° = \frac{A}{H}$

Step 3. Plug in and solve.

$\cos 63° = \frac{17}{x}$

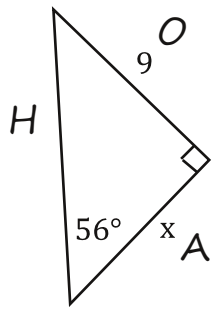
$x * \cos 63° = \frac{17}{x} * x$

$\frac{x(\cos 63°)}{\cos 63°} = \frac{17}{\cos 63°}$

$x = \frac{17}{\cos 63°}$

$x = \frac{17}{0.4540}$

$x \approx 37.44$




$\tan 56° = \frac{O}{A}$

$\tan 56° = \frac{9}{x}$

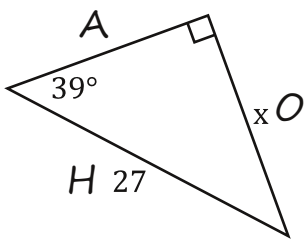
$x * \tan 56° = \frac{9}{x} * x$

$\frac{x(\tan 56°)}{\tan 56°} = \frac{9}{\tan 56°}$

$x = \frac{9}{\tan 56°}$

$x = \frac{9}{1.4826}$

$x \approx 6.07$




$\sin 39° = \frac{O}{H}$

$\sin 39° = \frac{x}{27}$

$27 * \sin 39° = \frac{x}{27} * 27$

$27(\sin 39°) = x$

$27(0.6293) = x$

$16.99 \approx x$

Don't be afraid to look back at these examples if you need to. Let's practice...