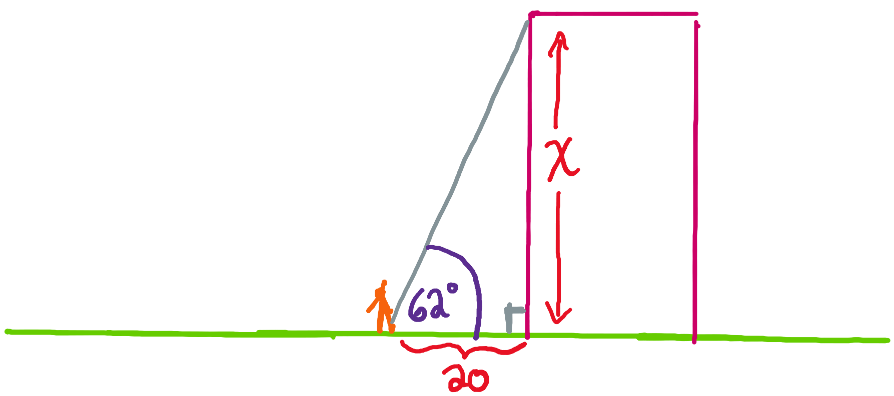
# Right-Triangle Trigonometry

Consider the following problem:

**A surveyor standing 20 feet away from a building looks up to the top of that building with an angle of elevation of 62°. How tall is the building?**

The only way to make sense of a problem like this is to draw a diagram:




As you can see, there is a geometric figure at the heart of this situation.

**A triangle.**

Our calculators are outfitted with a set of functions that allow us to calculate the ratio of the sides of a right triangle.

These functions all depend on the **angles** inside the triangle.

Here are the main three functions and their associated formulas:

**NOTE**:

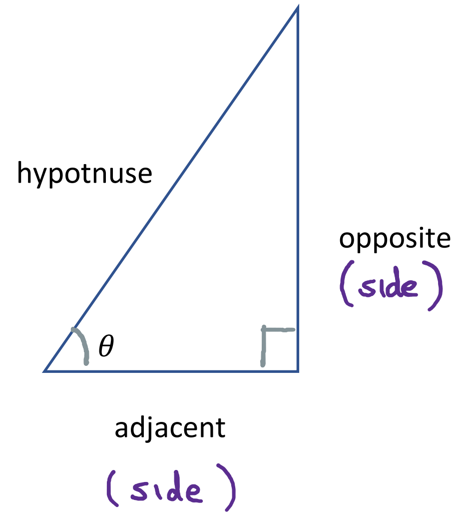
$$\sin(\theta) = \frac{opposite}{hypotnuse}$$

$$\cos(\theta) = \frac{adjacent}{hypotnuse}$$

$$\tan(\theta) = \frac{opposite}{adjacent}$$

Angle $\theta$ is "theta."

this is a Greek letter




To use these functions for angles measured in degrees, make sure that your calculator is set to "DEGREES" in its setting.

The angle inside the triangle can be *at most* 90°.

Solving real-life problems involving triangles . . .

. . . requires that you choose the right trig function . . .

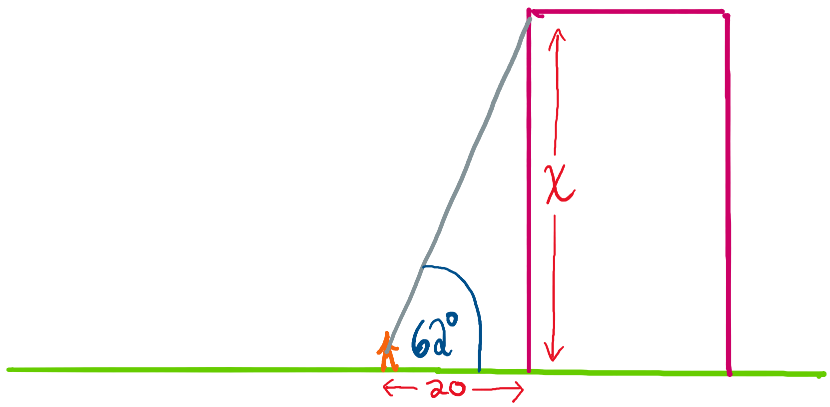
. . . which means **knowing which sides** are involved.

**This means that drawing a good diagram . . .**

**. . . is essential to figuring these out!!**

Let's go back to our real-life situation:

**A surveyor standing 20 feet away from a building looks up to the top of that building with an angle of elevation of 62°. How tall is the building?**




One side of the triangle is known, and another is the side we are trying to find.

Which trigonometric function involves **both** of these sides?

The answer is the **tangent** function:

$$\tan(\theta) = \frac{opposite}{adjacent}$$

$$\tan\,(62°) = \frac{x}{20}$$

Solving for $x$, we get

$$x = 20 * \tan(62°)$$

To calculate this as an exact answer, we must use our calculator.

We get

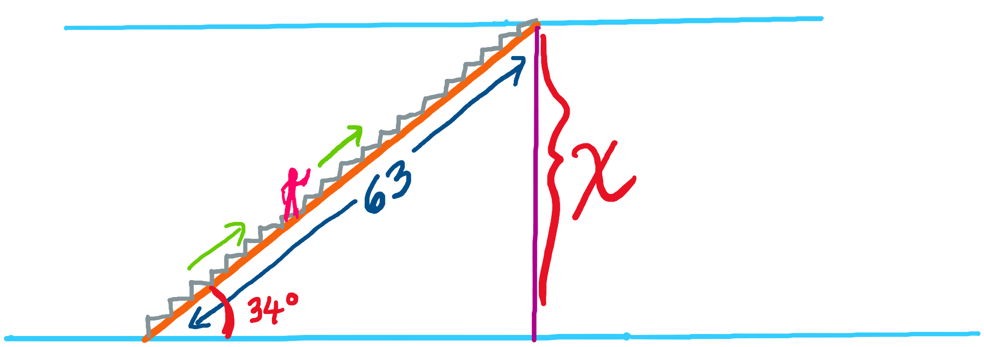
$$x = 37.6$$

**The building is approximately 37.6 feet tall!**

Let's try another one.

**An escalator in a mall takes a rider up a 34 degree angle relative to the floor. If the diagonal distance traveled by the rider is 63 feet, what is the vertical distance between floors?**

Again, we need to draw a diagram that accurately describes this situation, so that we can decide which sides of a right triangle are involved.




What are the sides that we must use in our equation?

As before, it's the side that we know, and the side that we want to find.

We **have** the hypotnuse . . . this is the diagonal distance traveled.

We **want** the opposite side . . . this is the vertical distance between floors.

What trigonometric function involves the hypotnuse with the opposite side?

$$\sin(\theta) = \frac{opposite}{hypotnuse}$$

$$\sin(34°) = \frac{x}{63}$$

Solving for $x$, we get

$$x = 63 * \sin(34°) = 35.2$$

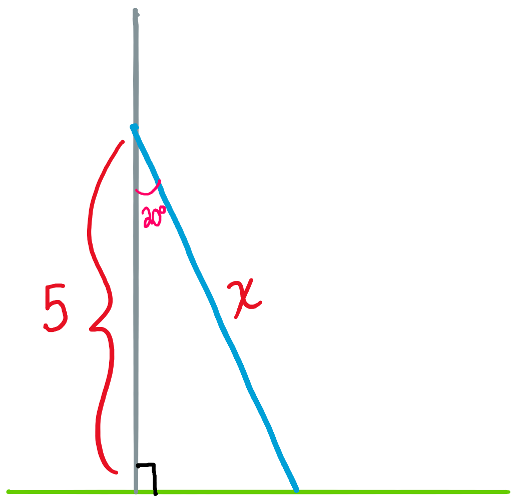
The vertical distance between floors is 35.2 feet.

Let's do one more where the algebra works out a bit differently:

**A ladder is leaned up against a wall. The top of the ladder forms a 20 degree angle with the wall. If the place the ladder touches is 5 feet from the ground, how long is the ladder?**

Go ahead on your own paper, see if you can draw this diagram and set up the equation.

Here's the diagram I get:




Notice that the angle is situated at the top of the triangle.

The opposite side is now the bottom side of the triangle . . .

. . . and the adjacent side is the side representing the wall.

Which sides are going to be represented in our equation?

We **want** the hypotnuse . . .

We **have** the adjacent side.

So we will use cosine:

$$\cos(\theta) = \frac{adjacent}{hypotnuse}$$

$$\cos(20°) = \frac{5}{x}$$

Notice that the algebra works out differently this time!!!

If you solve this the standard way rational equations are solved . . .

. . . we would multiply both sides by the LCD:

$$\cos(20°) = \frac{5}{x}$$

$$x * cos(20°) = 5$$

Which means we must divide by $\cos(20°)$ to both sides:

$$x * cos(20°) = 5$$

$$x = \frac{5}{\cos(20°)} = 5.32$$

The ladder is approximately 5 and one-third feet long!