# Degrees, Minutes, Seconds, and Decimals

There are two different ways we can use degrees. One is a decimal measure, such as 24.5 degrees. The other is in degrees, minutes, and seconds, such as 24 degrees 30 minutes. As imagined, decimal degrees are useful when we are using a calculator. Degrees, minutes, and seconds are used for things like latitude and longitude on topographic maps.

Minutes and seconds in degrees work similarly to minutes and seconds in an hour. In other words,

$$1 \text{ degree} = 60 \text{ minutes} \qquad 1 \text{ minute} = 60 \text{ seconds}$$

Based on this, how many seconds are there in a degree? _____

The idea of using a base-60 system (or "sexagesimal") dates back to the Babylonians in about 2,000 BCE. These are the same people who determined the use of 360 degrees in a circle.
(See http://gpsinformation.net/articles/degreesminutesseconds.htm for more information.)

Converting from one to the other involves multiplying or dividing by powers of 60. Let's look first at converting from decimal degrees to degrees, minutes, and seconds.

►Convert $35.72^0$ to degrees, minutes, and seconds.

$35^0$ is the whole part. We convert the 0.72 to minutes and seconds. We have 0.72 of a degree, which is $0.72 \times 1^0 = 0.72 \times 60$ minutes = 43.2 minutes.

So, this is $35^0$ 43.2 minutes. We can change the 0.2 minutes to seconds the same way. $0.2 \times 1$ minute = $0.2 \times 60$ seconds = 12 seconds.

Therefore, this is $35^0$ 43 minutes and 12 seconds, also written $35^0$ 43' 12".

In mathematical shorthand, minutes is ' and seconds is ".

**Convert into degrees, minutes, and seconds. (Round answers to the nearest second, if needed.)**

1) $152.65^0$                    2) $86.125^0$

When converting to decimal degrees from degrees, minutes, and seconds, we do the opposite. In other words, we divide by powers of 60 instead of multiply. We're going to use the idea that there are 3600 seconds in a degree to help.

►Convert $25^0$ 15' 30'' seconds to decimal degrees.

$25^0$ is still our whole that we're adding to. 15 minutes out of 60 minutes (1 degree) is the fraction of a degree that our minutes use, so this is $\frac{15}{60} = 0.25^0$. Also, 30 seconds out of 3600 seconds (also 1 degree) is the fraction of a degree that our minutes use, so this is $\frac{30}{3600} = 0.0083333^0$.

Add these all together: $25^0 + 0.25^0 + 0.0083333^0 = 25.2583333^0$. But, we'll round this to $25.258^0$.

**Convert to decimal degrees.**

1) $52^0$ 28' 22''                    2) $138^0$ 45' 58''