

# Converting between degrees and DMS

In the same way that we can express angles in degrees or in radians, we can also express them in **DMS** (degrees, minutes, seconds).

We already know that one full rotation is  $360^\circ$ . In DMS, a single degree is one of those 360 degrees. If we zoom in and divide that single degree into 60 parts, each of those parts is a minute. Then if we zoom in even more and divide each of those minutes into another 60 parts, each of those parts is a second.

Despite the fact that we use the words “minutes” and “seconds”, DMS angle measurement actually has nothing to do with time other than the fact that there are 60 seconds in a minute and 60 minutes in a degree in DMS, in the same way that there are 60 seconds in a minute and 60 minutes in an hour when we’re talking about time.

A DMS angle with 36 degrees 40 minutes 7 seconds, will be written as  $36^\circ 40' 7''$ . A  $72.75^\circ$  angle would be  $72^\circ 45' 0''$  because  $0.75 = 3/4$ , and three-fourths of 1 degree is three-fourths of 60 minutes, or exactly 45 minutes. A  $23^\circ$  angle would just be  $23^\circ 0' 0''$ , because there is no minutes or seconds part.

## Example

Convert from degrees to DMS.

$$\left(149\frac{3}{10}\right)^\circ$$



The angle in degrees is  $149^\circ$  plus  $3/10$ ths of a degree. Therefore, the degrees part in DMS is  $149^\circ$ . All we have to do is convert  $(3/10)^\circ$  to minutes and seconds. First, we'll convert  $(3/10)^\circ$  to minutes, and then if we get a decimal for the minutes, convert the remaining part to seconds.

There are  $60'$  in  $1^\circ$ , so we can multiply  $(3/10)^\circ$  by  $60'/1^\circ$  to convert the degrees to minutes.

$$\left(\frac{3}{10}\right)^\circ = \left(\frac{3}{10}\right)^\circ \left(\frac{60'}{1^\circ}\right)$$

$$\left(\frac{3}{10}\right)^\circ = \left[\frac{3(60)}{10}\right]'$$

$$\left(\frac{3}{10}\right)^\circ = \left(\frac{180}{10}\right)'$$

$$\left(\frac{3}{10}\right)^\circ = 18'$$

We've found that  $(3/10)^\circ$  converts to  $18'$ . Since 18 is an integer, there's nothing left to convert to seconds, so the angle in DMS is  $149^\circ 18' 0''$ .

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Let's try converting from DMS to degrees.

### Example

Express  $85^\circ 31' 22''$  in degrees.



We'll convert the seconds part first. We need to convert  $22''$  to minutes. We know that  $1' = 60''$ , so we'll multiply  $22''$  by  $1'/60''$  in order to cancel the seconds and be left with just minutes.

$$22'' = 22'' \left( \frac{1'}{60''} \right)$$

$$22'' = \left( \frac{22}{60} \right)'$$

$$22'' = \left( \frac{11}{30} \right)'$$

Now we know we have

$$\left( 31 + \frac{11}{30} \right)'$$

minutes. We need to combine this into one fraction by finding a common denominator.

$$31 + \frac{11}{30} = \frac{30(31) + 11}{30}$$

$$31 + \frac{11}{30} = \frac{930 + 11}{30}$$

$$31 + \frac{11}{30} = \frac{941}{30}$$



To convert this value for minutes into degrees, we'll multiply by  $1^\circ/60'$  in order to cancel the minutes and be left with just degrees.

$$31'22'' = \left( \frac{941}{30} \right)' \left( \frac{1^\circ}{60'} \right)$$

$$31'22'' = \left[ \frac{941}{30(60)} \right]^\circ$$

$$31'22'' = \left( \frac{941}{1,800} \right)^\circ$$

Putting this together with the  $85^\circ$  from the original angle measure  $85^\circ 31'22''$ , we get

$$\left( 85 \frac{941}{1,800} \right)^\circ$$

Let's look at how to convert an angle from DMS to degrees when the seconds part is a decimal number.

### Example

Convert  $74^\circ 10' 3.6''$  to degrees.

Convert 3.6 to a mixed number, and then to a fraction.

$$3.6 = 3 \frac{6}{10} = 3 \frac{3}{5} = \frac{18}{5}$$



Convert the minutes part to seconds.

$$10' = 10' \left( \frac{60''}{1'} \right)$$

$$10' = 10(60)''$$

$$10' = 600''$$

Combine these two values for seconds.

$$10'3.6'' = 600'' + \left( \frac{18}{5} \right)''$$

$$10'3.6'' = \left( 600 + \frac{18}{5} \right)''$$

$$10'3.6'' = \left[ \frac{5(600) + 18}{5} \right]''$$

$$10'3.6'' = \left( \frac{3,000 + 18}{5} \right)''$$

$$10'3.6'' = \left( \frac{3,018}{5} \right)''$$

Convert this value for seconds into minutes, and then from minutes into degrees.

$$10'3.6'' = \left( \frac{3,018}{5} \right)'' \left( \frac{1'}{60''} \right) \left( \frac{1^\circ}{60'} \right)$$



$$10'3.6'' = \left[ \frac{3,018}{5(3,600)} \right]^\circ$$

$$10'3.6'' = \left( \frac{3,018}{18,000} \right)^\circ$$

$$10'3.6'' = \left( \frac{503}{3,000} \right)^\circ$$

Add this value for degrees to the  $74^\circ$  from the original angle  $74^\circ 10'3.6''$  to get  $74^\circ 10'3.6''$  into degrees.

$$\left( 74 \frac{503}{3,000} \right)^\circ$$


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