



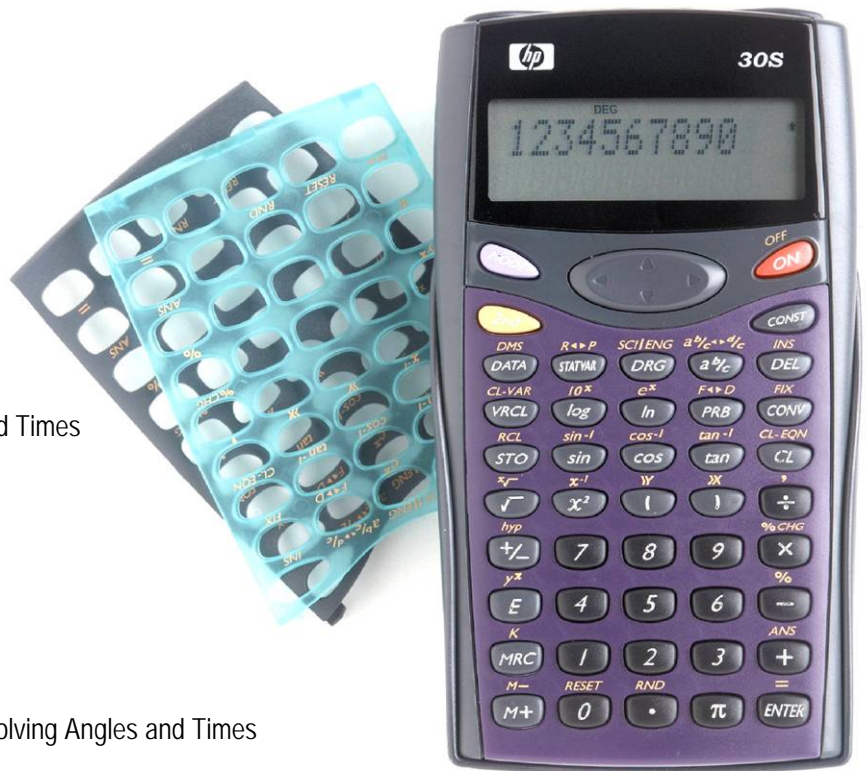
hp calculators

HP 30S Converting Angles and Times

Angle Measurements

Time Measurements

Practice Solving Problems Involving Angles and Times



Angle measurements

The amount of turning between two rays with a common origin, or the measure of change of direction, is what we call an angle. Angles cannot be measured in meters or yards. As measures of the amount of turning, we use degrees, radians and grads.

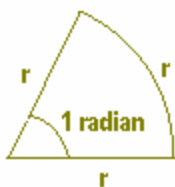


Figure 1.

A degree is one 360th of a complete turn and its symbol is $^{\circ}$. Just like a meter which has multiples and submultiples (e.g. kilometer, millimeter, etc), degrees are broken down into minutes and seconds. The minute ($'$) is one sixtieth of a degree, and the second ($''$) is one sixtieth of a minute. The radian is defined as the angle subtended by an arc of a circle of length equal to its radius (see figure 1). Its symbol is c (but this symbol is not widely used). Note that the counterclockwise direction of turning is taken to be positive. Grads are a measure of angle equal to one hundredth of a right angle. Grads are also known as gradians and grades. Angle units can be easily converted since:

$$2\pi \text{ radians} = 360 \text{ degrees} = 400 \text{ grads}$$

It is important to understand that there are two ways of expressing an angle in degrees: using decimal degrees and using degrees, minutes and seconds. In decimal degrees, an angle is simply given as 33.5 degrees, that is to say, 33 degrees and a half. In the degrees, minutes, seconds (or DMS) format, the same angle is 33 degrees, 30 minutes.

The HP 30S can work with angles in either measurement system and provides the DRG (DRG) and DMS (2nd DMS) menus to convert between them. It also has the \blacktriangleright DMS function ($\text{2nd DMS} \blacktriangleleft \text{ENTER}$) which is useful in converting between the two formats of angles expressed in degrees.

Time measurements

As units of time, a minute is equal to 60 seconds and a second (abbreviated as s) is the fundamental unit of time in the SI system. Since an hour has 60 minutes, a useful application of the conversion between decimal degrees and DMS angles is that the exact same conversion can also work for time. A measurement of 10.5 hours can be converted into 10 hours and 30 minutes by the *same* process by which an angle of 10.5 degrees can be converted into 10 degrees, 30 minutes (i.e. using the same function, \blacktriangleright DMS)

Practice solving problems involving angles and times

Example 1: Convert an angle of 25 degrees into radians.

Solution: Like many other calculators, the HP 30S operates in an angle mode that the user should specify before doing certain calculations such as trigonometric functions and coordinate conversions. Such mode can be selected in the DRG menu. Press DRG and use the \blacktriangleleft and \blacktriangleright keys to select the desired mode, in this case, select RAD and press ENTER . The RAD annunciator is lit. Now, all angles will be in radians unless stated otherwise. We need to enter 25 degrees, so we must find a way of telling the calculator that this angle is not expressed in radians. This is done by placing the degree symbol ($^{\circ}$) after the quantity 25, and such symbol is in the DMS menu. Press:

$\text{2} \text{ 5} \text{ 2nd DMS ENTER}$

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The entry line contains 25° . When this is evaluated by the ENTER key, the HP 30S will convert 25° into the current angle unit, i.e. radians.

Answer: 0.436332313 radians.

Example 2: Convert 25° into grads.

Solution: First of all, we have to set the angle mode to the unit into which we want to convert, i.e. grads. Press

DRG \blacktriangleright ENTER (assuming RAD was the current mode)

Note that the entry line now contains 25° again—the last calculation entered or the one being edited— so we just have to press ENTER to do the conversion.

Answer: 27.77777778 grads or $27\frac{7}{9}$ grads (press 2nd $\text{F}\leftrightarrow\text{D}$ ENTER to express the result as a mixed number).

Example 3: Convert an angle of $\frac{2\pi}{3}$ radians into decimal degrees.

Solution: Since the target unit is degrees, set the angle mode to degrees by pressing: DRG \blacktriangleright ENTER . The entry line still contains 25° from previous examples. Press CL to clear it. Now enter $2\pi/3$ and add a small r from the DMS menu to indicate that this quantity is expressed in radians:

$($ 2 π \div 3 $)$ 2nd DMS $\blacktriangleright\blacktriangleright\blacktriangleright$ ENTER

The entry line now reads $(2\pi/3)^r$. Parentheses are necessary because the $^\circ$, $'$, $''$, r and g functions take precedence over the division function. Press ENTER and the result line will contain the same value but expressed in decimal degrees.

Answer: 120°

Example 4: Add 120° to 4.1^r and express the result in both decimal degrees and in the DMS format.

Solution: 120° is already stored in ANS from the previous example, so press:

$+$ 4 $.$ $/$ 2nd DMS $\blacktriangleright\blacktriangleright\blacktriangleright$ ENTER ENTER

It returns the sum expressed in decimal degrees. To express this number in the DMS format, use the \blacktriangleright DMS function of the DMS menu. You need not reenter its argument, since it is taken from the ANS register, simply press:

2nd DMS \blacktriangleleft ENTER ENTER

Answer: 354.912696 or $354^\circ 54' 46''$

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Example 5: Convert an angle of 2.3714 degrees into DMS.

Solution: Assuming that the current angle mode is still set to degrees, press:

$\boxed{2} \boxed{\cdot} \boxed{3} \boxed{7} \boxed{1} \boxed{4} \boxed{2nd} \boxed{DMS} \boxed{\leftarrow} \boxed{ENTER} \boxed{ENTER}$

Answer: $2^\circ 22' 17.04''$ Note that seconds *are* expressed in decimal format.

Example 6: Convert an angle of 0.43 radians into DMS.

Solution: You don't have to convert 0.43 radians into decimal degrees first. Instead, use the \blacktriangleright DMS function directly:

$\boxed{\cdot} \boxed{4} \boxed{3} \boxed{2nd} \boxed{DMS} \blacktriangleright \blacktriangleright \blacktriangleright \boxed{ENTER} \boxed{2nd} \boxed{DMS} \boxed{\leftarrow} \boxed{ENTER} \boxed{ENTER}$

Answer: $24^\circ 38' 13.9''$

Example 7: Convert an angle of $118^\circ 27' 59''$ into decimal degrees.

Solution: On the HP 30S there is no specific function to convert DMS into decimal degrees, because such conversion is done automatically when processing the entry line, i.e. after pressing the \boxed{ENTER} key. The $^\circ$, $'$ and $''$ symbols are in the DMS menu:

$\boxed{1} \boxed{1} \boxed{8} \boxed{2nd} \boxed{DMS} \boxed{ENTER} \boxed{2} \boxed{7} \boxed{2nd} \boxed{DMS} \blacktriangleright \boxed{ENTER} \boxed{5} \boxed{9} \boxed{2nd} \boxed{DMS} \blacktriangleright \blacktriangleright \boxed{ENTER} \boxed{ENTER}$

In fact, the first two \boxed{ENTER} are not necessary – *selecting* the desired symbol in the DMS menu suffices:

$\boxed{1} \boxed{1} \boxed{8} \boxed{2nd} \boxed{DMS} \boxed{2} \boxed{7} \boxed{2nd} \boxed{DMS} \blacktriangleright \boxed{5} \boxed{9} \boxed{2nd} \boxed{DMS} \blacktriangleright \blacktriangleright \boxed{ENTER} \boxed{ENTER}$

The result line displays the angle in decimal degrees.

Answer: 118.4663889°

Example 8: Add 5 hours 33 minutes to 3 hours 58 minutes.

Solution: Remember that time measurements can be calculated using angle functions. This calculation can be done thus: $(5^\circ 33' + 3^\circ 58') \blacktriangleright$ DMS:

$\boxed{(} \boxed{5} \boxed{2nd} \boxed{DMS} \boxed{3} \boxed{3} \boxed{2nd} \boxed{DMS} \blacktriangleright \boxed{+} \boxed{3} \boxed{2nd} \boxed{DMS} \boxed{5} \boxed{8} \boxed{2nd} \boxed{DMS} \blacktriangleright \boxed{)} \boxed{2nd}$
 $\boxed{DMS} \boxed{\leftarrow} \boxed{ENTER} \boxed{ENTER}$

Answer: 9 hours and 31 minutes.

Note. More than one $^\circ$ or $'$ (or both) can be included in the same calculation. Its action depends on the current angular unit. For example, in grad mode $(A + B)^{rrr}$ is the same as $(A + B)(200/\pi)^3$. It does *not* work for $^\circ$ because degrees are parsed differently because of the DMS format.