



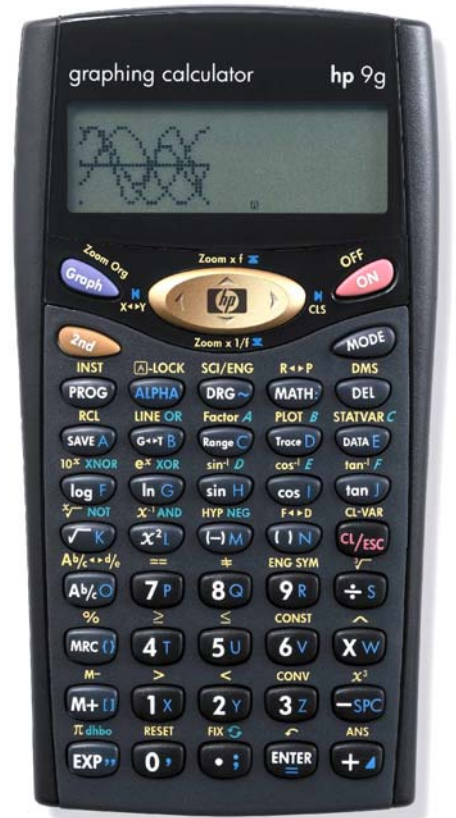
hp calculators

HP 9g 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 meters in meters or yards. As measures of the amount of turning, we use degrees, radians and grads.

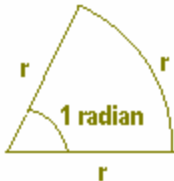


Figure 1.

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 $^{\circ}$ (though 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 9g can work with angles in either measurement system and provides the DRG ($\text{DRG} \rightarrow$) and DMS ($\text{2nd} \text{ DMS}$) menus to convert between them. It also has the \blacktriangleright DMS function ($\text{2nd} \text{ DMS} \blacktriangleleft \text{ENTER}$) which is useful when converting between the two formats of angles 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 (i.e. using the same function, \blacktriangleright DMS) an angle of 10.5 degrees can be converted into 10 degrees, 30 minutes.

Practice solving problems involving angles and times

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

Solution: Like many other calculators, the HP 9g 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 $\text{DRG} \rightarrow$ and use the \blacktriangleleft and \blacktriangleright keys to select the desired mode, in this case, select RAD and press ENTER . The angle mode annunciator is now a small R, for radians. Now, all angles will be in radians unless stated otherwise. We need to enter 25 degrees, so we must use 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:

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

The entry line contains 25° . When this is evaluated by pressing ENTER , the HP 9g 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 units into which we want to convert, i.e. grads. Press

$\text{DRG} \rightarrow \text{ENTER}$

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 convert the result into 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: $\text{DRG} \rightarrow \text{ENTER}$. The entry line still contains 25° from previous examples. Press CE/ESC 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:

$(\text{C})\text{N}$ 2nd π dbb \div 5 3 Z 2nd DMS \rightarrow \rightarrow \rightarrow ENTER

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

2nd DMS \leftarrow ENTER ENTER

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 T \cdot 1 X 2nd DMS \rightarrow \rightarrow \rightarrow ENTER ENTER

It returns the sum expressed in decimal degrees. To express this number in the DMS format, use the \rightarrow DMS function of the DMS menu. You don't need to reenter its argument, since it is taken from the ANS variable, just press:

2nd DMS \blacktriangledown ENTER ENTER

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

HP 9g Converting Angles and Times

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

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

$\text{2Y} \text{ .:} \text{ 3Z} \text{ 7P} \text{ 1X} \text{ 4T} \text{ 2nd} \text{ DMS} \text{ } \blacktriangledown \text{ ENTER}$

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:

$\text{. :} \text{ 4T} \text{ 3Z} \text{ 2nd} \text{ DMS} \text{ } \blacktriangleright \blacktriangleright \text{ ENTER} \text{ 2nd} \text{ DMS} \text{ } \blacktriangledown \text{ ENTER} \text{ ENTER}$

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

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

Solution: On the HP 9g 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 ENTER key. The $^\circ$, $'$ and $''$ symbols are in the DMS menu:

$\text{1X} \text{ 1X} \text{ 8O} \text{ 2nd} \text{ DMS} \text{ ENTER} \text{ 2Y} \text{ 7P} \text{ 2nd} \text{ DMS} \text{ } \blacktriangleright \text{ ENTER} \text{ 5U} \text{ 9R} \text{ 2nd} \text{ DMS} \text{ } \blacktriangleright \text{ ENTER}$

The result line displays the angle in decimal degrees.

Answer: 118.4663889 $^\circ$

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 this way: $(5^\circ 33' + 3^\circ 58') \blacktriangleright$ DMS:

$\text{()N} \text{ 5U} \text{ 2nd} \text{ DMS} \text{ ENTER} \text{ 3Z} \text{ 3Z} \text{ 2nd} \text{ DMS} \text{ } \blacktriangleright \text{ ENTER} \text{ +} \text{ 3Z} \text{ 2nd} \text{ DMS} \text{ ENTER} \text{ 5U} \text{ 8O} \text{ 2nd} \text{ DMS} \text{ } \blacktriangleright \text{ ENTER} \text{ } \text{2nd}$

Answer: 9 hours and 31 minutes.

Notes. All functions in the DMS menu can be inserted in a program, but the DRG menu is not shown in Program Edit mode. This means that a program cannot change the active angle unit, which has to be set before running the program. Neither the DRG menu nor the DMS menu can be displayed in Base-N mode.

Here's a trick that might be helpful: you can insert more than one $^\circ$ or $'$ (or both) in a calculation. Its action depends on the current angle mode. For example, in grad mode $(A + B)^{\text{fff}}$ is the same as $(A + B)(200/\pi)^3$ but saves five steps in a program. It does *not* work for $^\circ$ because degrees are parsed differently because of the DMS format.