



hp calculators

HP 9s 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 $^{\circ}$ (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 9s can work with angles in either measurement system and provides the $\text{DRG} \rightarrow$ function ($\text{2ndF} \text{ DRG}^-$) to convert between them. It also provides $\text{DMS} \rightarrow$ and $\text{2ndF} \text{ DMS}^-$ which are useful in 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 by which an angle of 10.5 degrees can be converted into 10 degrees, 30 minutes (i.e. using the same function, $\text{2ndF} \text{ DMS}^-$).

Practice solving problems involving angles and times

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

Solution: Like many other calculators, the HP 9s 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 by pressing the DRG key. Press DRG as many times as needed until the desired angle unit annunciator is lit. In this case, let's select DEG mode. Key in the angle value: $\text{2} \text{ . } \text{5}$ (the angle unit can be set before, while, or after keying in the quantity). To express this angle in radians, simply press $\text{2ndF} \text{ DRG}^-$. The angle mode is now RAD and the number in the display is converted into radians.

Answer: 0.436332313 radians.

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Example 2: Convert 25° into grads.

Solution: Since the display already shows 25° (expressed in radians) from the previous example, just press 2ndF DRG- once again! As simple as that. The angle mode is GRAD, and the angle in radians displayed when the DRG-> key was pressed is converted into grads.

Answer: 27.7777778 grads.

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

Solution: The current mode is assumed to be GRAD. Let's key in $2\pi/3$ radians:

$\text{2} \text{X} \text{2ndF} \pi \text{A} \div \text{3} \text{DRG} \text{DRG}$

To convert this angle into degrees press:

$\text{2ndF} \text{DRG-} \text{2ndF} \text{DRG-}$

Answer: 120°

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

Solution: To add angles on the HP 9s, they must be expressed in the same angle unit . 120° is already shown in the display, so let's add 4.1 radians converted into degrees:

$\text{+} \text{4} \cdot \text{1} \text{DRG} \text{2ndF} \text{DRG-} \text{2ndF} \text{DRG-} \text{ENTER}$

It returns the sum expressed in decimal degrees. To express this number in the DMS format, press $\text{2ndF} \text{DMS}$.

Answer: 354.912696 or 354° 54' 45"

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

Solution: Simply press:

2.3714 $\text{2nd} \rightarrow \text{DMS}$

In this case, the angle unit does not need to be set to degrees first, because $\text{2ndF} \text{DMS}$ already assumes the argument is expressed in degrees.

Answer: 2° 22' 17 "04. Note that seconds *are* expressed in decimal format (i.e. 17.04 .seconds)

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

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Solution: Let's key in 0.43 radians:

\circ 4 3 DRG

Now the display reads 0.43 and RAD is lit. Let's try pressing $\text{2ndF} \text{ } \overline{\text{D}}$ directly: RAD is still the angle mode and the display reads $0^{\circ}25'48''$. This is not 0.43 radians expressed in DMS (i.e. in degrees, minutes and seconds), but 0.43 *decimal degrees* expressed in DMS format, because the DMS and the $\text{2ndF} \text{ } \overline{\text{D}}$ functions are *not* affected by the current angle mode – they always work in degrees. So, we have to convert 0.43 into degrees first, *and then* this value can be expressed in degrees, minutes and seconds:

\circ 4 3 2ndF DRG- 2ndF DRG- $\text{2ndF} \text{ } \overline{\text{D}}$

Answer: $24^{\circ} 38' 13''8$

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

Solution: How can we enter the angle $118^{\circ} 27' 59''$? Simply keying in the given number, just remember that to enter the $^{\circ}$ and $'$ symbols, you must press the DMS key:

1 1 8 DMS 2 7 DMS 5 9 DMS

After the second DMS is pressed, the partial result $118.45 (= 118^{\circ} 27')$ is displayed.

Answer: 118.4663889° . The angular mode is irrelevant in this example, because the DMS key always assumes that its argument is in degrees.

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 is equivalent to: $(5^{\circ}33'+3^{\circ}58') \rightarrow^{\circ} ''$

5 DMS 3 3 DMS + 3 DMS 5 8 DMS ENTER $\text{2ndF} \text{ } \overline{\text{D}}$

Answer: 9 hours and 31 minutes.

Note. It is important to bear in mind the fact that the current angular unit is always indicated by the angular unit annunciator. Even though $\text{2ndF} \text{ } \overline{\text{D}}$ returns numbers such as $30^{\circ} 30' 0''$, the trigonometric functions will keep working in the current angle mode. For example, if the angular mode is set to RAD and the display reads $30^{\circ} 30' 0''$, pressing sin will return -0.793127239 , that is: the sine of **30.5 radians**.