



## hp calculators

### HP 33S Solving Simple Trigonometry Problems

The trigonometric functions

Degrees, radians and gradians

Practice working problems involving trig functions



## The trigonometric functions

The trigonometric functions, sine, cosine, tangent, and related functions, are used in geometry, surveying, and design. They also occur in the solutions to orbital mechanics, integration, and other advanced applications.

The HP 33S provides the three basic functions, and their inverse, or “arc” functions. These work in degrees, radians and gradians modes. In addition,  $\pi$  is provided as a function on the right-shifted “cos” key.

The secant, cosecant and cotangent functions are easily calculated using the  $\boxed{\text{COS}}$ ,  $\boxed{\text{SIN}}$ , and  $\boxed{\text{TAN}}$  keys respectively, followed by  $\boxed{1/x}$ . To help remember whether the secant function corresponds to the inverse sine or cosine, it can be helpful to note that the first letters of “secant” and “cosecant” are inverted in relation to those of “sine” and “cosine”, just as the secant and cosecant are the inverted cosine and sine functions.

## Trigonometric modes

The HP 33S can calculate trigonometric functions in any of these three modes: Degrees, Radians or Gradians.

## Practice working problems involving trig functions

Example 1: Select the appropriate angle mode.

Solution: Press the  $\boxed{\text{MODES}}$  key below the screen.

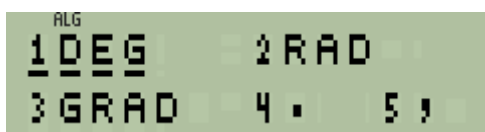


Figure 1

Press  $\boxed{1}$ ,  $\boxed{2}$  or  $\boxed{3}$  to select DEGrees, RADians or GRADians mode, or use the arrow keys  $\boxed{\leftarrow}$ ,  $\boxed{\rightarrow}$ ,  $\boxed{\uparrow}$  and  $\boxed{\downarrow}$  to select the required mode and then press  $\boxed{\text{ENTER}}$ . For example, to select RAD, press  $\boxed{2}$ .



Figure 2

Answer: The selected trigonometric mode is displayed at the top of the screen if it is RAD or GRAD. If no angle mode is shown, then the mode is degrees. The  $\boxed{\text{MODES}}$  command works the same way in algebraic and in RPN modes.

There are 360 degrees, or  $2\pi$  radians in a circle. Gradians mode divides each quarter of a circle into 100 parts, in a sort of decimal system, making 400 gradians in a circle.

It is very easy to forget that one angle mode is set but angles are being entered in a different mode. Making it a habit to check the angle mode is a good policy. The commands DEG, RAD and GRAD can be entered into programs, and it is worth using them to be sure that a program will work as required.

**Example 2:** What is the sine of  $\pi/2$  radians?

**Solution:** In RPN mode, calculate  $\pi/2$ , then press **SIN**.

**→** **π** **2** **÷** **SIN**.

In algebraic mode calculate  $\pi/2$  in parentheses, then press **SIN**.

**→** **(** **π** **÷** **2** **)** **SIN**. Following this with **ENTER** is not necessary, but it completes the calculation by putting an equals sign at the end.

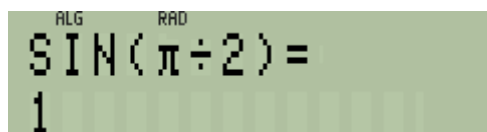


Figure 3

**Answer:** The sine of  $\pi/2$  radians is calculated as exactly 1. Answers will not always be exact as in this case. The HP 33S works with 12 decimal digits, so trigonometric calculations can be expected to be accurate to 12 decimal places. For example the sine of  $\pi$  radians is calculated as  $2 \times 10^{-13}$ , displayed as 2E-13, which is correctly equal to zero to 12 decimal places.

**Example 3:** Show that the rule  $\sin^2(x) + \cos^2(x) = 1$  applies correctly when  $x$  is  $45^\circ$ .

**Solution:** First, remember to set the required angle mode. Press **MODES** **1**.

In algebraic mode, work through the problem by calculating the sine, squaring it, then adding the square of the cosine:

**4** **5** **SIN** **x<sup>2</sup>** **+** **4** **5** **COS** **x<sup>2</sup>** **ENTER**

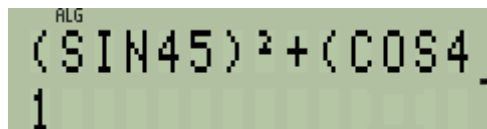


Figure 4

The same can be done in RPN mode. First, calculate the sine and cosine of  $45^\circ$ . Then add:

**4** **5** **ENTER** **SIN** **x<sup>2</sup>** **x↔y** **COS** **x<sup>2</sup>** **+**



Figure 5

**Answer:** Both the algebraic and the RPN calculations confirm that the rule  $\sin^2(x) + \cos^2(x) = 1$  applies correctly when  $x$  is  $45^\circ$ .

Example 4: A ladder is leaning against a vertical wall. The ladder is 6 meters long and the foot of the ladder is 3 meters from the base of the wall. What is the angle between the top of the ladder and the wall?

Solution: In RPN mode, divide the side opposite the angle by the long side and get the arc sine:

**3** **ENTER** **6** **÷** **←** **ASIN**

In algebraic mode, calculate 3/6 in parentheses, then the arc sine:

**(** **3** **÷** **6** **)** **←** **ASIN**

Following this with **ENTER** is not necessary, but it completes the calculation by putting an equals sign at the end.

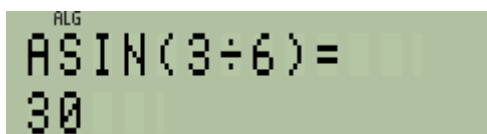


Figure 6

Answer: The ladder is at an angle of 30 degrees from the wall.