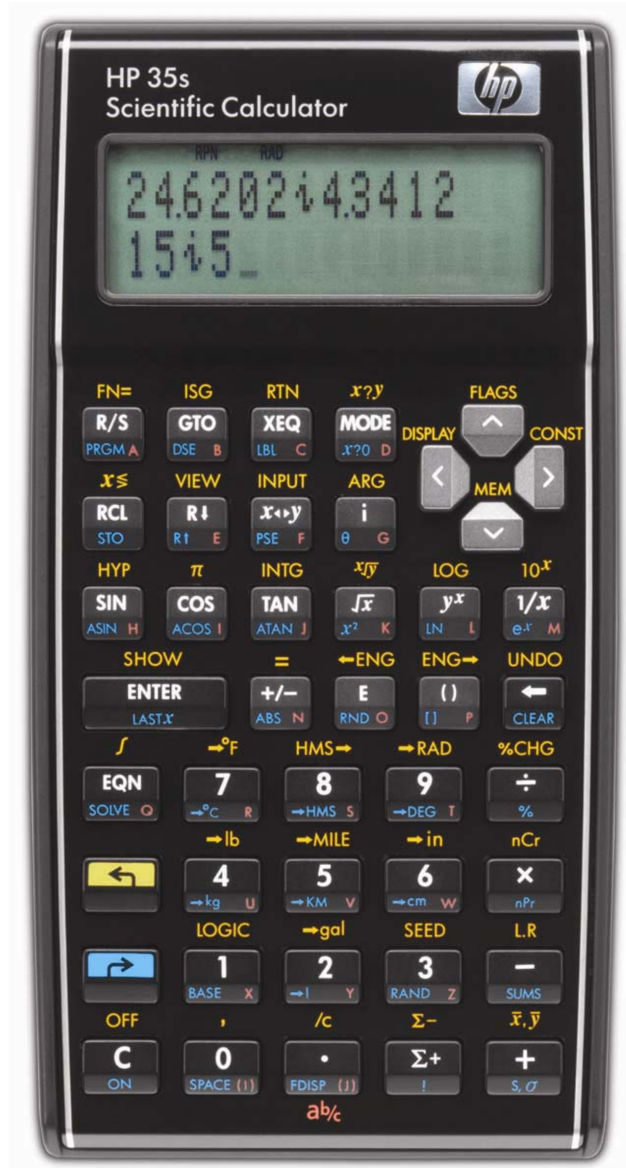
hp calculators

HP 35s Solving Trigonometry Problems

The trigonometric functions

Trigonometric modes

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 solutions to orbital mechanics, integration, and other advanced applications.

The HP 35s provides the three basic functions, and their inverse, or “arc” functions. These work in degrees, radians and gradians modes. In addition, π is provided as a function on the left-shifted “cos” key, and the sign function is found in the INTG menu on the left-shifted “tan” key.

The secant, cosecant and cotangent functions are easily calculated using the COS, SIN, and TAN keys respectively, followed by 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.

The display mode can be changed to show either rectangular and radial coordinates. This can therefore be useful in some trigonometric calculations.

Trigonometric modes

The HP 35s 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 MODE key.

Figure 1

Press 1, 2 or 3 to select DEGrees, RADians or GRADians mode, or use the arrow keys <, >, ^ and v to select the required mode and then press ENTER. For example, to select RAD, press 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 it is degrees. The MODE command works the same way in algebraic and in RPN modes.

There are 360 degrees, or 2 π 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.

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

Example 2: What is the sine of π/2 radians?

Solution: In RPN mode, calculate π/2, then press [SIN].

[↰] [π] [2] [÷] [SIN].

In algebraic mode, press [SIN] then calculate π/2.

[SIN] [↰] [π] [÷] [2] [ENTER].

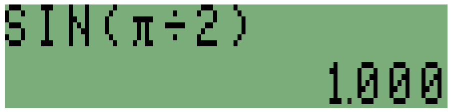


Figure 2

Answer: The sine of π/2 radians is calculated as exactly 1

Example 3: Show that the rule $\sin^2(x) + \cos^2(x) = 1$ applies correctly when x is 30°.

Solution: First, remember to set the required angle mode. Press [MODE] [1].

In algebraic mode:

[↱] [x^2] [SIN] [3] [0] [>] [>] [+] [↱] [x^2] [COS] [3] [0] [ENTER]

Figure 3

In RPN mode:

[3] [0] [SIN] [↱] [x^2] [3] [0] [COS] [↱] [x^2] [+]

Figure 4

Answer: Both the algebraic and the RPN calculations confirm that the rule $\sin^2(x) + \cos^2(x) = 1$ applies correctly when x is 30°.

Example 4: A designer wants to use triangular tiles with sides 3 inches, 5 inches and 7 inches long, to put a mosaic on a floor. What is the angle opposite the 7 inch side? Will it be possible to lay three tiles next to each other with this angle pointing inwards?

Solution: Use the cosine rule to calculate the angle. The cosine rule states that for any triangle with sides a, b and c, and angle A facing side a:

$$a^2 = b^2 + c^2 - 2 \cdot b \cdot c \cdot \mathrm{COS}(A)$$

Figure 5

From this, A can be calculated as:

$$A=ACOS\left(\frac{b^2+c^2-a^2}{2\cdot b\cdot c}\right)$$

Figure 6

In RPN mode, the calculation can be done like this:

[5] [↱] [x^2] [3] [↱] [x^2] [+] [7] [↱] [x^2] [−] [2] [÷] [5] [÷] [3] [÷] [↱] [ACOS]

In algebraic mode, calculate:

[↱] [ACOS] [( )] [↱] [x^2] [5] [>] [+] [↱] [x^2] [3] [>] [−] [↱] [x^2] [7] [>] [>] [÷] [2] [÷] [5] [÷] [3] [ENTER]

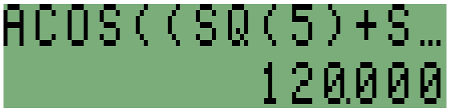


Figure 7

Answer: The angle opposite the 7 inch side is 120 degrees. This means that three tiles will fit together exactly with this angle pointing inwards, as they would make up 360 degrees.

Example 5: 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, press:

[↱] [ASIN] [3] [÷] [6] [ENTER].

Figure 8

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

Example 6: A vector has components –5 in the X direction and –8 in the Y direction. In what direction does it point?

Solution: It would be possible to divide –5 by –8 and calculate the arc tangent, giving approximately 32 degrees, but this would not specify the quadrant in which the vector lies. Fortunately, the 35s complex display modes provide a way to view the complete arc tangent function that recognizes in which quadrant an angle lies.

The solution is the same in either RPN or algebraic mode.

First, set the display mode to rΘa.

Then, enter the Y magnitude, press the [i] key, and enter the X magnitude. Then press [ENTER].

[8] [+/-] [i] [5] [+/-] [ENTER]

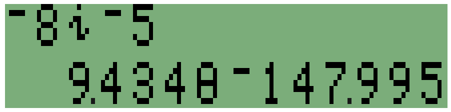


Figure 9

Answer: The vector direction is very nearly –148 degrees as indicated by the value shown after the Θ.

Example 7: A program is being written to automate calculations with vectors. The program needs to know whether the Y component of directions in calculations such as the above is in the +Y or the –Y direction. How can the direction be obtained?

Solution: The SIGN function (the first choice in the [↰] [INTG] menu) gives the sign of a number, +1 or –1. Thus it is enough to obtain the sign of the angle calculated in the previous example and to check whether it is +1 or –1.

In RPN mode follow the above calculation with:

[↰] [ARG] [↰] [INTG] [ENTER]

In algebraic mode follow the above calculation with:

[↰] [INTG] [ENTER] [↰] [ARG] [↱] [LAST x] [ENTER]

Figure 10

Answer: The sign is –1, so the vector direction is down, not up. Note that the [ENTER] following [↰] [INTG] will choose the first option in the displayed menu.