

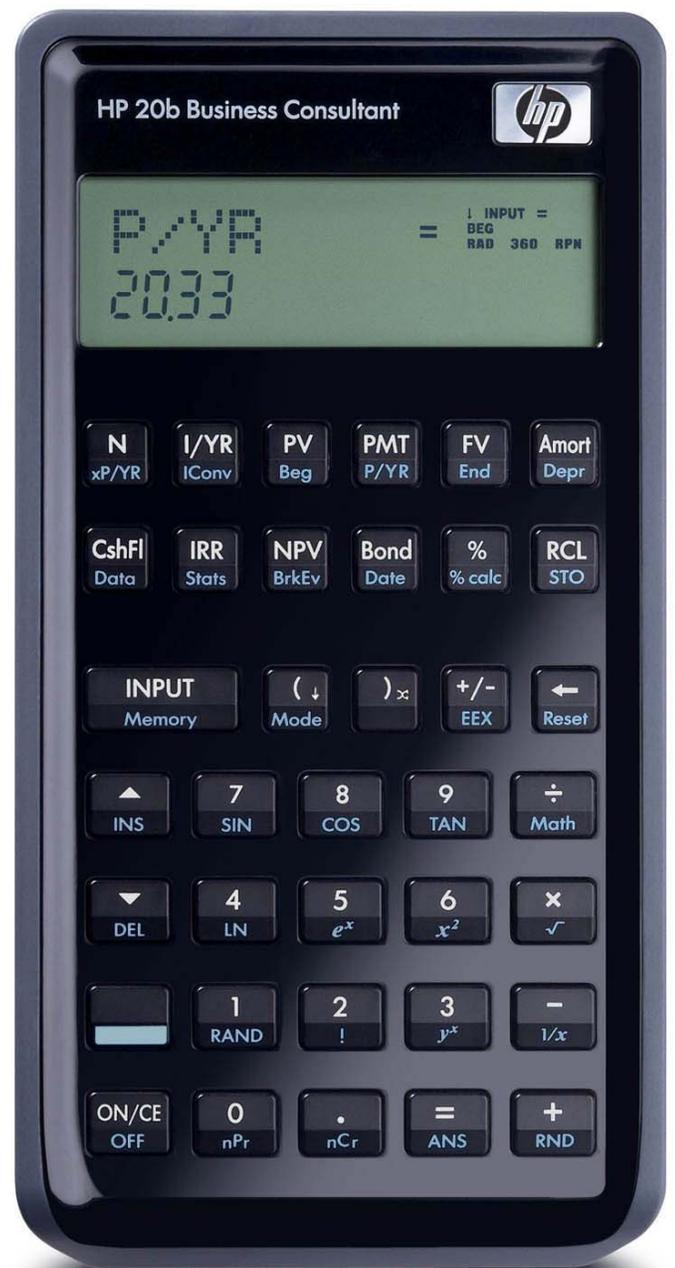


## hp calculators

HP 20b Solving Simple Trigonometry Problems

The trigonometric functions

Practice working problems involving trig functions

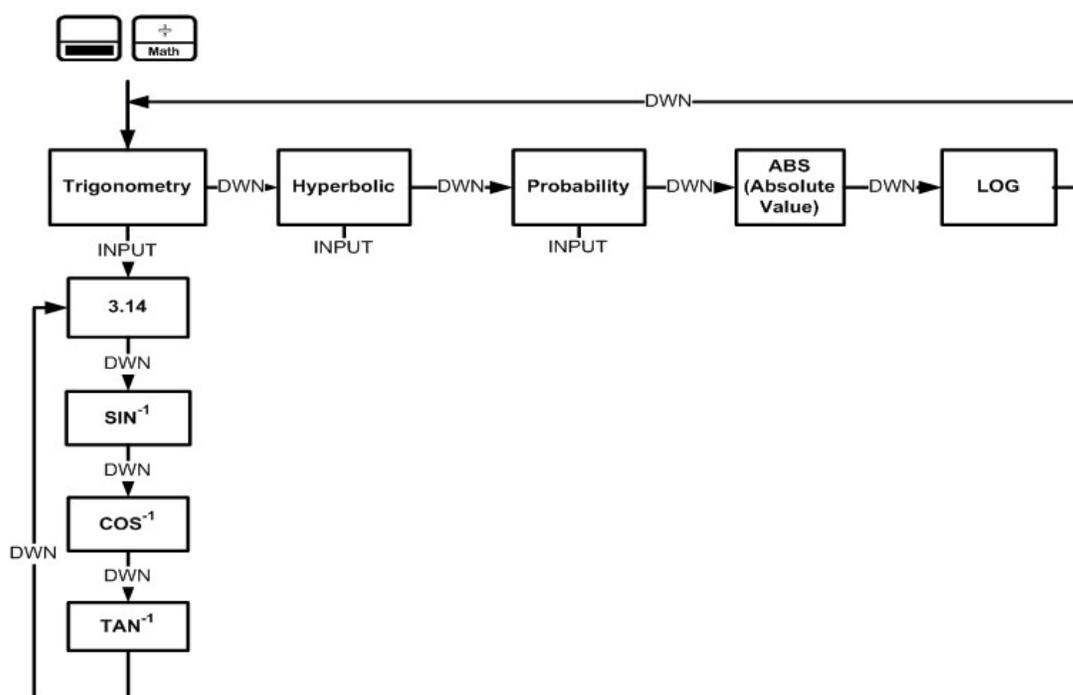


## The trigonometric functions

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 20b provides the three basic functions, and their inverse, or “arc” functions. These work in degrees or radians modes. In addition, the value of  $\pi$  approximated to 3.14159265359 is provided as the first function in the MATH menu in the Trigonometry sub-menu.

Sine, cosine and tangent are found as the shifted functions of the  $\boxed{7}$ ,  $\boxed{8}$ , and  $\boxed{9}$  keys. The inverse functions are found in the Trigonometry portion of the math menu, which is accessed by pressing  $\boxed{\text{Math}}$  and is shown below. The sub-menu items for the hyperbolic and probability portions of the math menu are not shown in this menu map.



After pressing  $\boxed{\text{Math}}$ , press  $\boxed{\downarrow}$  to scroll through the menu items, starting with *Trigonometry*. The *Trigonometry*, *Hyperbolic*, and *Probability* items have sub-menus. Press  $\boxed{\text{INPUT}}$  when any of these items are displayed to access the functions within the sub-menus. Press  $\boxed{\text{ON/CE}}$  to cancel and leave the Math menu. Press  $\boxed{\text{Math}}$  to return to the top of the Math menu at any time.

Radians or Degrees mode is set in the  $\boxed{\text{Mode}}$  menu. When radians mode is active, RAD is displayed in the right corner of the display. When degrees mode is active, the RAD annunciator in the display is turned off. When calculating a problem involving trigonometry, be sure that the right mode is active. If you get an answer you were not expecting, it might be the result of using the wrong mode.

To use one of the inverse trig functions, you would have the value in the display and scroll through the MATH menu until you get to the proper function. For example, if you wish to find the angle in degrees that has the sine of 0.5, you would press  $\boxed{0} \boxed{\cdot} \boxed{5} \boxed{\text{Math}} \boxed{\text{INPUT}} \boxed{\downarrow} \boxed{\text{INPUT}}$  and you would see the answer of 30 degrees. As another example, to use the value of  $\pi$ , you would press  $\boxed{\text{Math}} \boxed{\text{INPUT}} \boxed{\text{INPUT}}$ .

Practice working problems involving trig functions

Example 1: Set the angle mode to radians.

Solution: Press  .



Figure 1

If it already shows radians mode, press  to exit the mode menu. If it shows degrees mode, press  and  to exit the menu. Check the display to make sure the appropriate mode is set.

Answer: The selected trigonometric mode is displayed at the top of the screen if it is RAD. If no angle mode is shown, then the mode is degrees. There are 360 degrees, or  $2\pi$  radians in a circle.

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

Solution: In RPN mode, press:

In chain or algebraic mode,



Figure 2

Answer: The sine of  $\pi/2$  radians is calculated as exactly 1. Answers will not always be exact as in this case. The HP 20b rounds answers to 12 decimal digits for display after calculating them with 15 digits. For example the sine of  $\pi$  radians is calculated as  $-2.06761537357 \times 10^{-13}$ , 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. If the HP 20b is in radians mode as required for problems 1 and 2, press   .

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

In RPN mode, press:         



Figure 3

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

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**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:

6 INPUT 3 ÷  Math INPUT 

In algebraic mode, 6 ÷ 3 =  Math INPUT 



Figure 4

**Answer:** The ladder is at an angle of 30 degrees from the wall. Press  to complete the calculation. If you do not, then in algebraic mode, the result is still pending, awaiting an .

**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:

$$a^2 = b^2 + c^2 - 2 \cdot b \cdot c \cdot \cos(A)$$

Figure 5

From this, A can be calculated as:

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

Figure 6

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

5  x<sup>2</sup> 3  x<sup>2</sup> + 7  x<sup>2</sup> - 2 ÷ 5 ÷ 3 ÷  Math INPUT  

In algebraic mode, calculate:

( 5  x<sup>2</sup> + 3  x<sup>2</sup> - 7  x<sup>2</sup> ) ÷ ( 2 × 5 × 3 ) ) =  Math INPUT  



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. Press  to complete the calculation. If you do not, then in algebraic mode, the result is still pending, awaiting an .