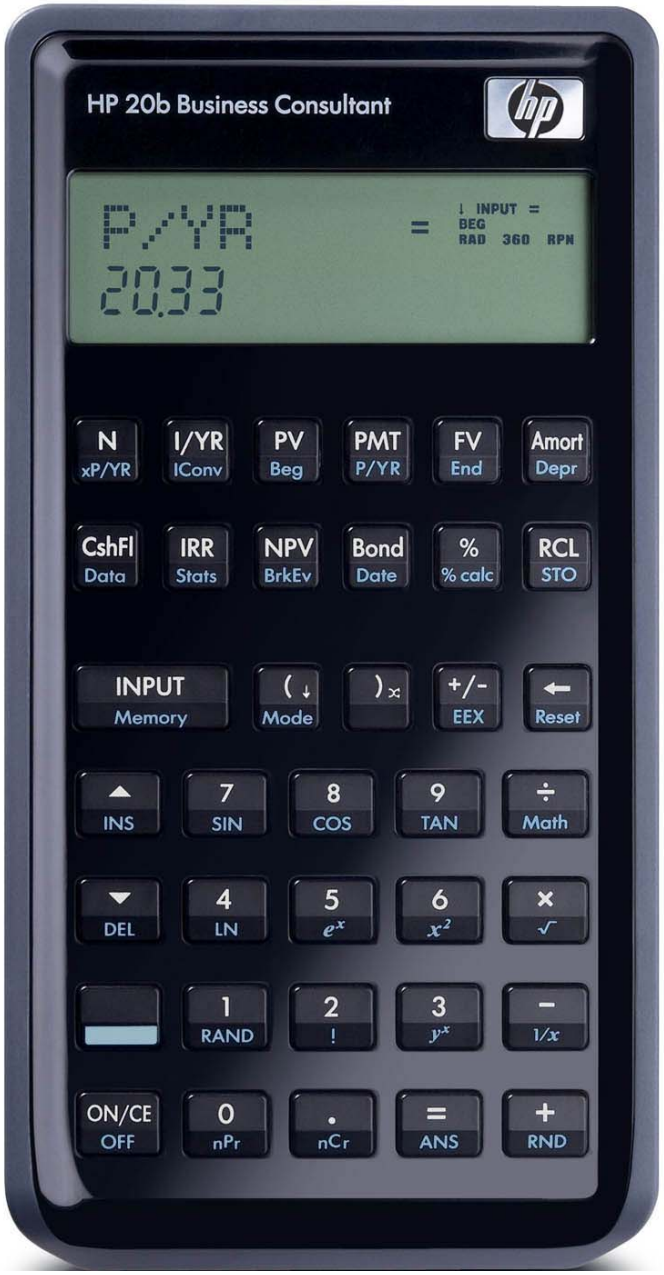
hp calculators

HP 20b Hyperbolic functions

Hyperbolic trigonometric functions

Practice using hyperbolic trigonometric functions



Hyperbolic trigonometric functions

Trigonometric functions are often called “circular” functions, because the value for the cosine and sine of an angle lie on the unit circle defined by $X^2 + Y^2 = 1$ (points on the unit circle will have the X and Y coordinate of (Cosine(theta), Sine(theta))). Hyperbolic trigonometric functions have a similar relationship, but with the hyperbola defined by the equation $X^2 – Y^2 = 1$. Given a value for Z, the hyperbolic sine is calculated by evaluating the following:

$$\frac{e^{Z}-e^{-Z}}{2}$$

Figure 1

The hyperbolic cosine is calculated by evaluating the following:

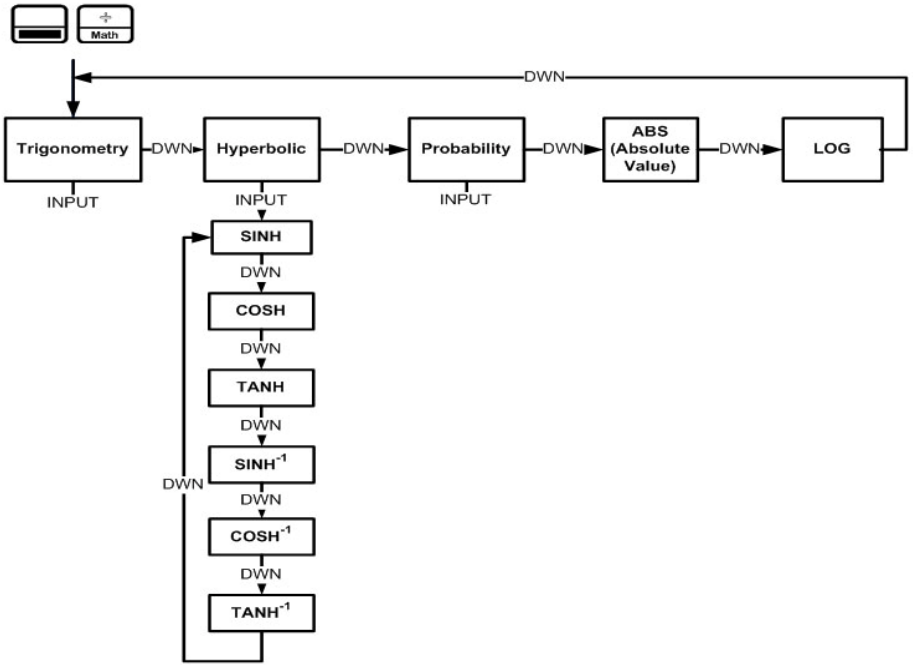
$$\frac{e^{Z}+e^{-Z}}{2}$$

Figure 2

Assume that Z is 3. The position on the unit hyperbola $X^2 – Y^2 = 1$ is defined by the point (COSH(Z),SINH(Z)), where COSH is the hyperbolic cosine and SINH is the hyperbolic sine. The value for the SINH(3) is equal to 10.0179 and the value of COSH(3) is 10.0677. When 10.0677 x 10.0677 – 10.0179 x 10.0179 is evaluated, the value is 1, so the point falls on the unit hyperbola. The hyperbolic tangent is defined as the hyperbolic sine divided by the hyperbolic cosine.

Hyperbolic functions have applications in many areas of engineering. For example, the shape formed by a wire freely hanging between two points (known as a catenary curve) is described by the hyperbolic cosine (COSH). Hyperbolic functions are also used in electrical engineering applications.

The hyperbolic functions, and their inverses, are found in the Hyperbolic portion of the math menu, which is accessed by pressing [▬] [Math] and is shown below. The sub-menu items for the trigonometry and probability portions of the math menu are not shown in this menu map.



HP 20b Hyperbolic functions

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

To use one of the hyperbolic 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 hyperbolic sine of 2, you would press [2] [Math] [▼] [INPUT] [INPUT] and you would see the answer of 3.63. To find the inverse hyperbolic tangent of 0.3, you would press [Math] [▼] [INPUT] [▼] [▼] [▼] [▼] [▼] [INPUT] and see the answer of 0.29. Alternatively, since the inverse hyperbolic tangent is the last item in the Hyperbolic sub-menu, you could access it more quickly by pressing [Math] [▼] [INPUT] [▲] [INPUT].

Practice using hyperbolic trigonometric functions

Example 1: Find the Hyperbolic Sine of 2.

Solution: In RPN mode, press: [Math] [▼] [INPUT]
In chain or algebraic mode, press: [Math] [▼] [INPUT]

Figure 3

Answer: 3.63. Press [INPUT] or [=] to complete the calculation. If you do not, then in algebraic mode, the result is still pending, awaiting an [INPUT] or [=].

Example 2: A tram carries tourists between two peaks that are the same height and 437 meters apart. Before the tram latches onto the cable, the angle from the horizontal to the cable at its point of attachment is 63 degrees. How long does it take the tram to travel from one peak to the other, if the tram moves at 135 meters per minute?

Solution: The travel time is given by the following formula:

$$t = \frac{437 \times \tan(63 \text{ degrees})}{135 \times \text{ASINH}(\tan(63 \text{ degrees}))}$$

If the 20b is in Radians mode, change it to Degrees mode to calculate the tangent value.

To change to degrees mode, press: [Mode] [▼] [INPUT]

In RPN mode, press: [4] [3] [7] [INPUT] [6] [3] [TAN] [×] [ANS] [Math] [▼] [INPUT] [▼] [▼] [▼] [INPUT] [1] [3] [5] [×] [÷]

In chain or algebraic mode, press: [4] [3] [7] [×] [6] [3] [TAN] [÷] [(] [1] [3] [5] [×] [6] [3] [TAN] [Math] [▼] [INPUT] [▼] [▼] [▼] [INPUT] [)] [=]

Figure 4

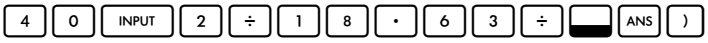
Answer: The travel time between the peaks is just under four and one half minutes.

Example 3: A cable is strung between two poles that are 40 feet apart, with the cable attached to each pole at a height of 30.436 feet above the level ground. At the midpoint between the poles, the cable is 18.63 feet above the level ground. What is the length of the cable required between the two poles?

Solution: The length of the cable is described by the formula below, where a is the lowest height of the cable and D is the distance between the two poles:

L = 2 a SINH ((D/2) / a)

In RPN mode, press:



Note: in RPN mode,) performs a swap of the X and Y registers. This is the X<>Y command with which RPN users are familiar. A reminder of this function is imprinted on the bottom right of this key.

Continuing in RPN mode, press:

In chain or algebraic mode, press:

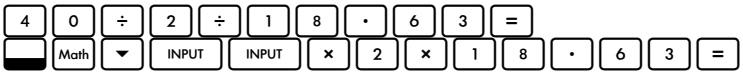


Figure 7

Answer: The length of the cable will be 48.14 feet.