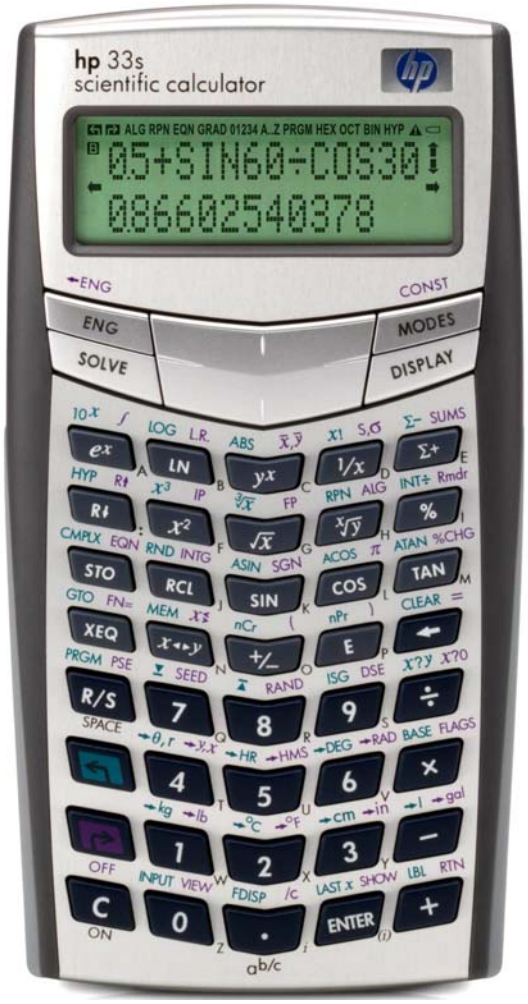
# hp calculators




HP 33S  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.

On the HP 33S, hyperbolic functions are access by pressing the [↰] [HYP] keys and then the appropriate trigonometric key or inverse trigonometric key.

## Practice using hyperbolic trigonometric functions

Example 1: Find the Hyperbolic Sine of 2.

Solution: [2] [HYP] [SIN]


Figure 3

Answer: 3.62686. Figure 3 shows the display in algebraic mode.

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:

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

Assuming the 33S is in Radians mode, change it to Degrees mode to calculate the tangent value.

Assuming RPN mode: [MODES] [1] (Sets Degrees mode)
[4] [3] [7] [ENTER] [6] [3] [TAN] [×] [↰] [LAST x] [↰] [HYP] [↰] [ASIN] [1] [3] [5] [×] [÷]


Figure 4

Assume algebraic mode: [MODES] [1] (Sets Degrees mode)
[4] [3] [7] [×] [6] [3] [TAN] [÷] [↱] [(] [1] [3] [5] [×] [6] [3] [TAN] [↰] [HYP] [↰] [ASIN] [↱] [)] [ENTER]


Figure 5

Answer: The travel time between the peaks is just under four and one half minutes. Figure 4 shows the display in RPN mode, while Figure 5 shows the display in algebraic mode.

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:

$$L = 2a \cdot \text{SINH}\left(\frac{D/2}{a}\right)$$

Assuming RPN mode
[4] [0] [ENTER] [2] [÷] [1] [8] [.] [6] [3] [÷] [↰] [LAST x] [x⇄y] [↰] [HYP] [SIN] [x⇄y] [2] [×] [×]


Figure 6

Assuming algebraic mode
[4] [0] [÷] [2] [÷] [1] [8] [.] [6] [3] [ENTER] [↰] [HYP] [SIN] [×] [2] [×] [1] [8] [.] [6] [3] [ENTER]

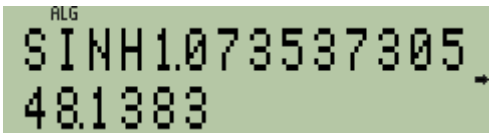



Figure 7

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