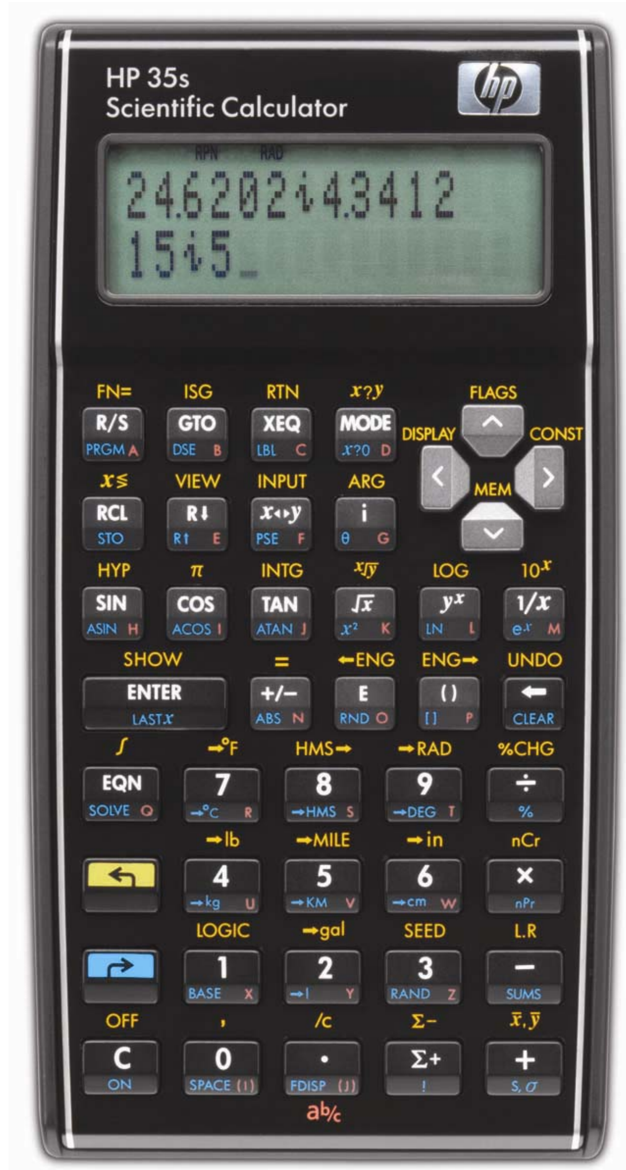
# hp calculators

HP 35s Advanced uses of logarithmic functions

Log and antilog functions

Practice using log and antilog functions



## Log and antilog functions

Before calculators like the HP 35s became easily available, logarithms were commonly used to simply multiplication. They are still used in many subjects, to represent large numbers, as the results of integration, and even in number theory.

The HP 35s has four functions for calculations with logarithms. These are the “common” logarithm of “x”, [↰] [LOG], its inverse, [↰] [$10^x$], the “natural” logarithm of “x”, [↱] [LN] and its inverse, [↱] [$e^x$].

Common logarithms are also called “log to base 10” and the common logarithm of a number “x” is written

$$LOG_{10}\ x \quad \text{or just} \quad LOG\ x$$

Natural logarithms are also called “log to base *e*” and the natural logarithm of a number “x” is written

$$LOG_e\ x \quad \text{or} \quad LN\ x$$

Logarithms can be calculated to other bases, for example the log to base two of x is written

$$LOG_2\ x$$

Some problems need the logarithm of a number to a base n, other than 10 or *e*. On the HP 35s these can be calculated using one of the formulae

$$LOG_n\ x = LOG_{10}\ x \div LOG_{10}\ n$$

$$LN_n\ x = LN_e\ x \div LN_e\ n$$

[↰] [$10^x$] and [↱] [$e^x$] are also called “antilogarithms” or “antilogs”. [↱] [$e^x$] is also called the “exponential” function or “exp”. Apart from being the inverses of the log functions, they have their own uses. [↰] [$10^x$] is very useful for entering powers of 10, especially in programs where the [E] key can not be used to enter a power that has been calculated. [↱] [$e^x$] is used in calculations where exponential growth is involved.

The [$y^x$] function can be seen as the base “n” antilog function. If $10^x$ is the inverse of $\log_{10}$ x and $e^x$ is the inverse of $\log_e$ x, then $y^x$ is the inverse of $\log_y$ x.

## Practice using log and antilog functions

Example 1: Find the common logarithm of 2.

Solution: In RPN mode type [2] [↰] [LOG]
In algebraic mode type [↰] [LOG] [2] [ENTER]

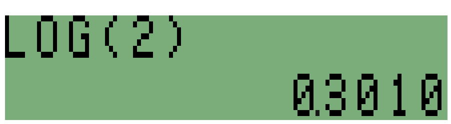



Figure 1

Answer: The common logarithm of 2 is very nearly 0.3010.

Example 2: A rare species of tree has a trunk whose cross-section changes as 1/x with the height x. (Obviously this breaks down at ground level and at the tree top.) The cross section for any such tree is given by A/x, where A is the cross-section calculated at 1 meter above the ground. What is the volume of the trunk between 1 meter and 2 meters above ground?

Solution: The volume is obtained by integrating the cross-section along the length, so it is given by the integral:

$$\int_1^2 \frac{A}{x}\,dx$$

Figure 2

It is possible to evaluate this integral using the HP 35s integration function, but it is much quicker to note that the indefinite integral of 1/x is LN x. The result is therefore

V = A (LN2 – LN1)

Since LN 1 is 0, this simplifies to

V=A LN2

In RPN mode type [2] [↱] [LN]. In algebraic mode type [↱] [LN] [2] [ENTER].

No one is likely to measure tree heights to an accuracy of more than three significant digits, so set the HP 35s to display the answer with just 3 digits after the decimal point, by pressing [↰] [DISPLAY] [1] [3]


Figure 3

Answer: Figure 3 shows that the log to base *e* of 2 is close to 0.693, so the volume is 0.693A cubic meters.

Example 3: What is the log to base 3 of 5? Confirm the result using the [$y^x$] function.

Solution: Using the equations given above, the log to base 3 of 5 can be calculated as ($\log_{10}$ 5)/($\log_{10}$ 3).

In RPN mode, press: [5] [↰] [LOG] [3] [↰] [LOG] [÷]

In algebraic mode, press: [↰] [LOG] [5] [>] [÷] [↰] [LOG] [3] [ENTER]


Figure 4

That this is correct can be confirmed if the following keys are pressed.

In RPN mode: [3] [$x↔y$] [$y^x$]

In algebraic mode: [3] [$y^x$] [↱] [LAST$x$] [ENTER]

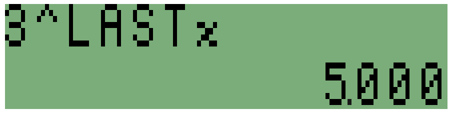



Figure 5

Answer: The log to base 3 of 5 is 1.465 within the current accuracy setting of the calculator, as shown by Figure 5. Calculating 3 to this power gives 5.000 which confirms that the correct value for the log had been obtained.

Example 4: An activity of 200 is measured for a standard of $Cr^{51}$ (with a half-life of 667.20 hours). How much time will have passed when the activity measured in the sample is 170? The formula for half-life computations is shown in Figure 7.

$$A = A0 \cdot \left(\frac{1}{2}\right)^{\frac{t}{\tau}}$$

Figure 6

Solution: Rearrange the equation to solve for t, as in Figure 8.

$$t = \tau \cdot \frac{LN\left(\frac{A}{A0}\right)}{LN\left(\frac{1}{2}\right)}$$

Figure 7

Now calculate t. In RPN mode:

[6] [6] [7] [.] [2] [ENTER] [1] [7] [0] [ENTER] [2] [0] [0] [÷] [↱] [LN] [×] [.] [5] [↱] [LN] [÷]

In algebraic mode:

[6] [6] [7] [.] [2] [×] [↱] [LN] [1] [7] [0] [÷] [2] [0] [0] [>] [÷] [↱] [LN] [.] [5] [ENTER]


Figure 8

Answer: 156.435 hours. Figure 8 shows the result in algebraic mode.