



hp calculators

HP 30S Working with Expressions

Expressions on the HP 30S



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The HP 30S provides a most useful way of evaluating an expression containing one or more variables for various values: an entire expression can be *stored as a variable*, which, when retrieved and executed, will prompt you for values of all the variables used in the expression. The main purpose is to find the numerical value of a formula for specific values of the variables involved.

Example 1: Store the expression $x^2 - 3xy + 4y^2$ in memory.

Solution: Expressions can only be stored into the EQN variable, in any operating mode other than STAT because EQN cannot be recalled nor modified in STAT mode (but the contents is not lost). Let's work in HOME, then: press MODE 0 . Now, key in the expression as follows:

VRCL x^2 $-$ 3 VRCL ENTER VRCL $+$ 4 VRCL x^2

The entry line contains the expression $A^2 - 3AB + 4B^2$. We have used the variables A and B because they are easier to type in. X, Y, X1, and X2 can also be used but their values will be overwritten by the solutions of linear systems and quadratic equations. As you well know, if you now press the ENTER key, the expression will be evaluated using the current values of the A and B variables. Instead, press:

STO ENTER

The expression is now stored in memory, specifically in the EQN variable.

Answer: The value displayed in the result line is the result of evaluating the expression using the current A and B values.

Example 2: Calculate the value of the previous expression when A and B take the values: $-\frac{2}{3}$ and $\frac{\sqrt{3}}{2}$, respectively.

Solution: We'll now see why expressions are so useful. Press:

VRCL ENTER

The expression stored in the previous example is displayed in the entry line. Nothing to shout about, so far; retrieving past calculations is what the history stack is all about. But press ENTER one more time: the calculator *prompts for the value of A*. It displays the current value (even if it's zero) so that you can reuse it or edit it (press 2nd INS first, if needed)—or simply key in the new value, which overwrites the previous digit (press CL to clear the whole entry). As well as numbers, you can key in almost any expression (which can also include variables), the value of which will be stored in the variable in question. In this example $A = -\frac{2}{3}$, so press:

CL +/- 2 $\text{a}^{\text{b/c}}$ 3 ENTER

The calculator now prompts for B:

CL . 5 $\sqrt{\quad}$ 3 ENTER

The answer is shown in the result line.

Answer: Rounding to four decimal digits, 5.1765.

Example 3: Calculate $f(z,t) = e^{\frac{z+t}{2}}$ for $z=10$ and $t = \pi$, and for $z = 8$ and $t = 0.001400682$.

Solution: We'll store $f(z, t)$ in EQN as a function of C and D:

2nd e^x $+/-$ \cdot 5 $($ VRCL \blacktriangleright \blacktriangleright $+$ VRCL \blacktriangleright \blacktriangleright \blacktriangleright $)$ \blacktriangleright STO \blacktriangleleft ENTER

Note that $f(z, t)$ overwrites the previous expression.

Let's find $f(10, \pi)$:

VRCL \blacktriangleleft ENTER ENTER CL $/$ 0 ENTER CL IT ENTER

The result, 0.001400682, is displayed. We can press VRCL \blacktriangleleft ENTER ENTER again to find $f(8, 0.001400682)$, but there's a quicker way: just press $\blacktriangle\blacktriangle$ and C=10 appears in the entry line. Let's enter its new value:

8 CL ENTER . Note that the value calculated for $f(10, \pi)$ is the same as the value that D must take now.

We can use the ANS variable to enter it, even though we have already keyed in the C value, because values keyed in when prompting messages are displayed are not stored in ANS!

CL 2nd ANS ENTER

Answer: $f(10, \pi) = 0.001400682$ and $f(8, 0.001400682) = 0.018302816$.

Example 4: Calculate $f(x,y) = \sqrt{x} \cdot 10^y$ for $x = 2$ and $y = \sin\left(\frac{5\pi}{3}\right)$, and for $x = 2$ and $y = 0.1$.

Solution: We'll store $f(x, y)$ as $\sqrt{A} \cdot 10^B$:

$\sqrt{}$ VRCL ENTER \blacktriangleright 2nd 10^x VRCL \blacktriangleright ENTER \blacktriangleright STO \blacktriangleleft ENTER

Oops! "DOM Error"?? What's wrong? Even when stored in EQN, expressions are evaluated using the current values, and the result appears in the result line. Trouble is that this evaluation is done *before* storing the expression, so any error generated during the evaluation prevents the STO command from working. In this case, the error was caused by the square root because A contains a negative number, stored in Example 2. Other likely errors are DIVIDE BY 0, OVERFLOW. This is an unfortunate side effect which we'll have to learn to live with!

We have to store a valid value in A, then. To do so press:

CL CL 0 STO ENTER

Don't worry, the expression is still in the history stack ... :

▲▲ $\overline{\text{ENTER}}$

Now, let's find $f(2, \sin(5\pi/3))$. Press:

$\overline{\text{VRCL}}$ \blacktriangleleft $\overline{\text{ENTER}}$ $\overline{\text{ENTER}}$ $\overline{\text{CL}}$ $\overline{2}$ $\overline{\text{ENTER}}$

We now have to enter the B value, which is expressed in radians, but note that you can set the angle unit *while* the prompting message is displayed (if needed, press $\overline{\text{DRG}}$, select RAD and press $\overline{\text{ENTER}}$):

$\overline{\text{CL}}$ $\overline{\text{sin}}$ $\overline{5}$ $\overline{\pi}$ $\overline{\div}$ $\overline{3}$ $\overline{\text{ENTER}}$

Since A is still 2 in the second evaluation, $f(2, 0.1)$, we have to press the ▲ key only once:

▲ $\overline{\cdot}$ $\overline{1}$ $\overline{\text{CL}}$ $\overline{\text{ENTER}}$

Answer: Rounding to four decimal digits, $f(2, \sin(5\pi/3)) = 0.1925$ and $f(2, 0.1) = 1.7804$

Example 5: The physicist Frank Benford found that if n is the first digit of a quantity arising from what he called "counts of natural phenomena" (e.g. lengths of rivers, volumes of lakes, etc.) then the probability that such a number starts with n is equal to:

$$P(n) = \log\left(\frac{n+1}{n}\right) \quad \text{Benford's law}$$

Find $P(1)$ through $P(9)$ expressed as percentages.

Solution: Press $\overline{1}$ $\overline{\text{STO}}$ $\overline{\text{ENTER}}$ to store 1 in A, because A must be nonzero... but also because that 1 will be our first argument. Let's store the right-hand expression in EQN:

$\overline{\log}$ $\overline{(\overline{\text{VRCL}} \overline{\text{ENTER}} + \overline{1} \overline{\text{)}} \overline{\div}} \overline{\text{VRCL}} \overline{\text{ENTER}} \blacktriangleright \overline{E}$ $\overline{2}$ $\overline{\text{STO}}$ \blacktriangleleft $\overline{\text{ENTER}}$

And now let's calculate $P(1)\%$:

$\overline{\text{VRCL}}$ \blacktriangleleft $\overline{\text{ENTER}}$ $\overline{\text{ENTER}}$

"A=1" is displayed. Press $\overline{\text{ENTER}}$ to find $P(1)$. To repeat the calculation, simply press:

▲ $\overline{2}$ (overwrites the previous 1, note that you need not press $\overline{\text{CL}}$ first) $\overline{\text{ENTER}}$ (returns $P(2)\%$)
 ▲ $\overline{3}$ $\overline{\text{ENTER}}$ (returns $P(3)\%$)
 ▲ $\overline{4}$ $\overline{\text{ENTER}}$ (returns $P(4)\%$)
 ▲ $\overline{5}$ $\overline{\text{ENTER}}$ (returns $P(5)\%$)
 ▲ $\overline{6}$ $\overline{\text{ENTER}}$ (returns $P(6)\%$)
 ▲ $\overline{7}$ $\overline{\text{ENTER}}$ (returns $P(7)\%$)
 ▲ $\overline{8}$ $\overline{\text{ENTER}}$ (returns $P(8)\%$)
 ▲ $\overline{9}$ $\overline{\text{ENTER}}$ (returns $P(9)\%$).

Answer: Rounding to one decimal place:

n	1	2	3	4	5	6	7	8	9
P(n)%	30.1	17.6	12.5	9.7	7.9	6.7	5.8	5.1	4.6

Note. The HP 30S learning modules *Solving Quadratic Equations* (examples 7,8 and 9) and *Solving Linear Systems* (example 8) illustrate the use of expressions in Q SOLV and L SOLV modes, respectively.