



## hp calculators

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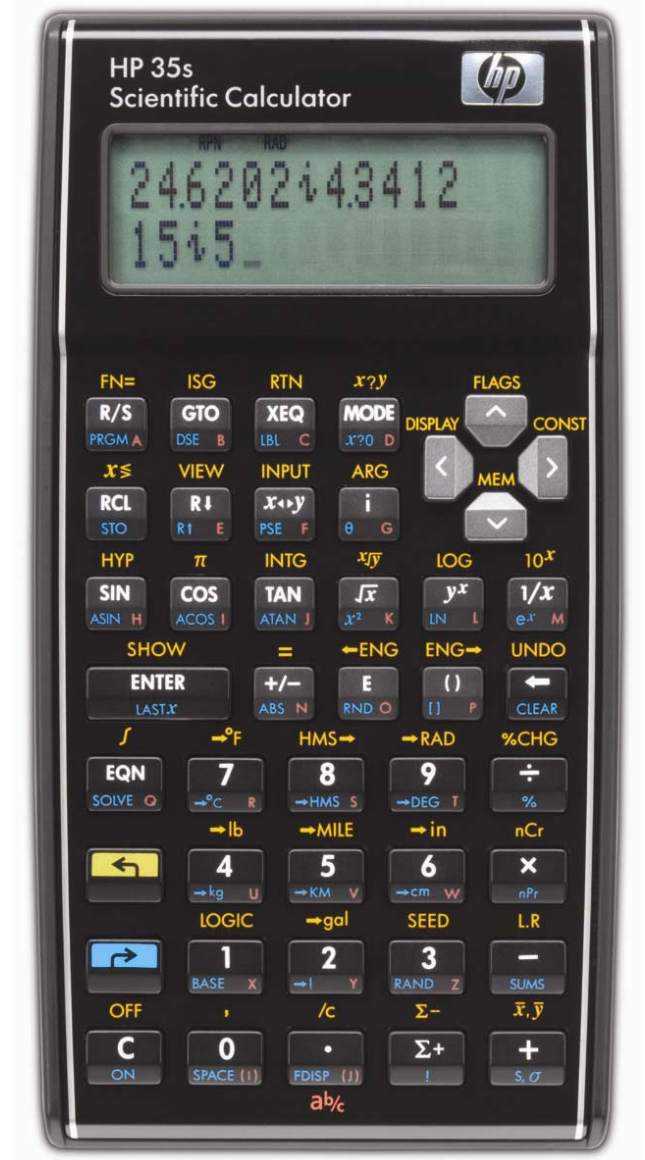
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## Calculation modes

The HP 35s allows calculations to be made in “RPN” mode, in “algebraic” mode, or in “Equation” mode.

RPN mode is the traditional way most HP calculators work. To add 1 and 2, keys are pressed in the order  $\boxed{1} \boxed{\text{ENTER}} \boxed{2} \boxed{+}$ . This mode is very suitable for calculations where the user is working towards a solution, without having a particular formula to work on.

Algebraic mode is the way many newer HP calculators work. It is also the way most other calculators work. To add 1 and 2, keys are pressed in the order  $\boxed{1} \boxed{+} \boxed{2} \boxed{\text{ENTER}}$  as shown in Figure 1. This way of working is most suitable when the user just needs to type a formula and get an answer.



Figure 1

In Equation mode, the user types a formula or an expression the way it looks in a textbook and saves it in a list of equations. Then the equation can be used once or repeatedly, for different values of variables. Equations can also be used with the integration command and the solver command.

For complicated tasks that need to be repeated, writing a program is the best solution. Programs can be written in RPN mode or in algebraic mode, and can include equations.

Equation mode, RPN mode, and programs are described in other training aids.

Note: When doing the examples press  $\boxed{\text{MODE}} \boxed{4}$  to set algebraic mode. The selected mode is shown at the top of the calculator screen, as in Figure 1.

## Functions of a single number in algebraic

As an example, in algebraic mode, to square a number, the  $\boxed{\text{x}^2}$  key is pressed, the number is typed, and  $\boxed{\text{ENTER}}$  is pressed. This is the way all functions except factorial ( $\boxed{\text{x}!}$ ) work. Factorial is pressed after the number.

## A simple example in algebraic

**Example 1:** A gardener wants to plant a triangular piece of ground and to put protective edges around the plot. The plot will have a right angle and the two shorter edges will be 1.2m long and 0.5m long. How long will the third edge be?

**Solution:** The length can be calculated using Pythagoras' formula. From  $a^2 + b^2 = c^2$  the third side is:

$$c = \sqrt{a^2 + b^2}$$

To try this, first set algebraic mode, pressing  $\boxed{\text{MODE}} \boxed{4}$ . Now to square 1.2 and 0.5, type:

$\boxed{\text{x}^2} \boxed{1} \boxed{\cdot} \boxed{2} \boxed{\text{ENTER}}$   
 $\boxed{\text{x}^2} \boxed{\cdot} \boxed{5} \boxed{\text{ENTER}}$



Figure 2

**Answer:** The second result, 0.25, is on the lower line of the calculator screen. In algebraic mode, the formula or expression used to calculate this result is shown on the upper line. The previous result, 1.2 squared, has vanished, though it can still be used, as will be shown.

**Note:** When functions are printed, some come before the number, for example  $\sqrt{2}$  or  $\sin(30)$ . Others are printed with the function after the number, examples are  $6!$  or  $5^2$ . Calculators rarely work like this; on many algebraic calculators, all functions of one number are calculated by typing the function first, followed by the number, usually in parentheses (brackets). This is how algebraic mode on the HP 35s works, with the exception of factorial as noted above.

### Arithmetic calculations with two numbers

To add two numbers in algebraic mode, it is necessary to type or calculate the first number, press  $\boxed{+}$ , to type or calculate the second number and press  $\boxed{\text{ENTER}}$  to finish the calculation.

**Note:** On some Algebraic calculators, a key marked  $\boxed{=}$  finishes a calculation, but on the HP 35s,  $\boxed{\text{ENTER}}$  is used. The  $\boxed{=}$  key is used only when an equation is being typed in Equation mode.

In this example, the two numbers have been calculated already (assuming you have just completed the previous example). One is shown on the lower line, so it is enough to press  $\boxed{+}$  begin the addition. The HP 35s will show the display in Figure 3.

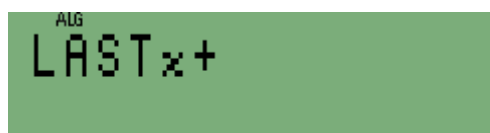


Figure 3

LASTx is the terminology the HP 35s uses to refer to the last number calculated, which in this case will be the 1.44. The HP 35s is ready for the second number for the addition. It can be found in the second level of the HP 35s operational stack, referred to as register Y. (The other two levels above register Y are called register Z and T). To use the number in the second level of the stack at this point, press  $\boxed{\text{R}\downarrow}$ . The HP 35s will then show the display in Figure 4.



Figure 4

Pressing the  $\boxed{\text{R}\downarrow}$  (roll down) key in algebraic mode allows for the selection of previous results from the four level stack. The  $\boxed{\leftarrow}$  and  $\boxed{\rightarrow}$  keys are used to move the cursor under the stack register desired and  $\boxed{\text{ENTER}}$  is used to select that value. When the  $\boxed{\text{R}\downarrow}$  key is pressed, the cursor is always initially positioned under the Y register.

In this instance, the value in the Y register is exactly what we want. Press  $\boxed{\text{ENTER}}$  and the HP 35s will show the display as in Figure 5.



Figure 5

**ENTER** must be pressed to finish the addition. The result is shown in Figure 6.



Figure 6

To find the square root of this result, is press **√x** **→** **LASTx** **ENTER**.



Figure 7

Alternatively, if you know at the beginning the values to be used and what you wish to do with them, you could key in this calculation in one step by pressing:

**√x** **→** **x²** **1** **.** **2** **>** **+** **→** **x²** **.** **5** **ENTER**



Figure 8

**Answer:** The length of the third edge of the garden plot is 1.3m. One purpose of this example is to illustrate the way algebraic mode can be used “interactively” rather than merely keying in a problem that is already written out. However you need to solve your problem, the HP 35s can handle it.

**Another example - the area of a piece of carpet**

Here is another example to show how arithmetical calculations involving addition and multiplication are carried out using parentheses in algebraic mode.

**Example 2:** A new carpet is needed for two rooms, one 6 yards long, one 8 yards long, both 5 yards wide. What is the total area of carpet to be bought?

**Solution:** The area is calculated using the expression  $(6 + 8) \times 5$ .

In algebraic mode the total length can be calculated first, 6 yards + 8 yards. Then the length is multiplied by the width, 5 yards.

So these keys would be typed:

$( )$			This enters the open and close the parentheses to put around (6+8)
$6$	$+$	$8$	This gives the 6+8
$>$			This places the cursor outside the parentheses to continue
$\times$	$5$		This multiplies by 5
$\text{ENTER}$			This tells the calculator that the formula is finished so it can now get the answer

and the formula and answer would be shown

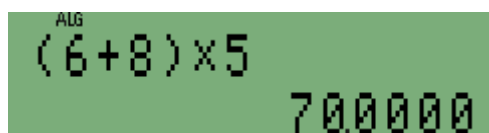


Figure 9

**Answer:** The total area of carpet is 70 square yards.

To continue a calculation after pressing the  $\text{ENTER}$  it is enough to press another calculation key. For example if the carpet costs \$17.32 per square yard, it is easy to continue the calculation and get the total price of the carpet. First press  $\times$ . Then finish the calculation by pressing  $17.32 \text{ ENTER}$ , as below.

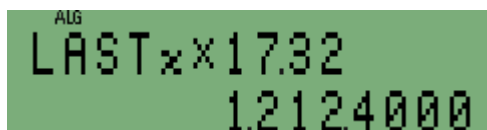


Figure 10

The total price is \$1,212.40.

To begin a new calculation, the first number in that calculation is typed. The  $\text{LAST}_x$  key brings the answer from the last calculation into the new calculation.

For example another way to calculate the price of the carpet would be to type  $17.32 \times \text{LAST}_x \text{ ENTER}$ .



Figure 11

**Why "Algebraic"?** You can see that the formula to calculate was typed and is displayed in the way it looks when it is written down on paper in algebraic notation. That is why this calculation mode is called Algebraic Mode. Algebraic notation was developed over centuries as a shorthand way of writing things such as "add the number eight to the number six and multiply the result by the number five".

### Making corrections

In algebraic mode, digits in a number that is being typed can be deleted with the  $\leftarrow$  key. If a number has been completed or calculated, this key deletes it completely.

In algebraic mode, addition, subtraction, multiplication and division are not carried out immediately. If a wrong key was pressed,  $\boxed{+}$  and  $\boxed{-}$  should be followed by a  $\boxed{0}$  and  $\boxed{\times}$  or  $\boxed{\div}$  should be followed by a  $\boxed{1}$ .

### Functions of two numbers

Unlike functions of a single number, the arithmetical operations  $\boxed{+}$ ,  $\boxed{-}$ ,  $\boxed{\times}$  and  $\boxed{\div}$  use two numbers, but there are also some mathematical functions that use two numbers.

An often-used two-number function is the exponentiation or “power” function, and this works in the same way as  $\boxed{+}$ ,  $\boxed{-}$ ,  $\boxed{\times}$  and  $\boxed{\div}$  in algebraic mode.

**Example 3:** What is 2 to the power 10?

**Solution:** The calculation is  $2^{10}$  using the  $\boxed{y^x}$  key.

In algebraic mode, type 2, press  $\boxed{y^x}$ , type 10, and press  $\boxed{\text{ENTER}}$  to complete the calculation.

$\boxed{2} \boxed{y^x} \boxed{10} \boxed{\text{ENTER}}$



Figure 12

**Answer:** Two to the power 10 is 1,024, often called 1k in computing.

$\boxed{y^x}$  works exactly like the arithmetical operators and is often considered to be one of them. Other two-number functions work as shown in the next example.

**Example 4:** What is the permutation of 69 items taken 2 at a time?

**Solution:** This involves the permutation function, or the  $\boxed{nPr}$  key.

In algebraic mode, type  $\boxed{nPr}$



Figure 13

The permutation function is presented in the display with the required open and close parentheses as well as a comma inside them to separate the two required arguments. The cursor is blinking to indicate the insertion point – where the next key pressed will be entered. This insertion point is exactly where it should be to enter the first argument.

Now type  $\boxed{69}$ . This is the first argument. To move past the comma, press  $\boxed{\>}$ . Now press  $\boxed{2} \boxed{\text{ENTER}}$ .

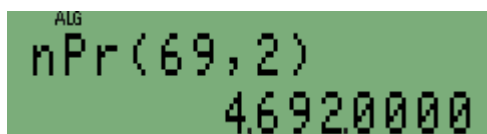


Figure 14

**Answer:** The permutation of 69 items taken 2 at a time is 4,692. Note that it was not necessary to move beyond the closing parenthesis before pressing **ENTER**.

Percentage functions are used in algebraic mode and are explained in the business training guide on Percentages.

Working with complex numbers, with pairs of numbers representing rectangular or polar coordinates and with pairs of numbers in statistical operations are described in training aids on these subjects.

### Algebraic operator precedence

In algebraic mode the HP 35s calculates using “operator precedence”. This means that a combination of several **+** and **-** operations (or several **×** and **÷** operations) is calculated from left to right, but **×** and **÷** have a higher “precedence” and are carried out before **+** and **-**.

**Example 5:** What is the result of calculating  $1 \div 2 \div 3$  in algebraic mode?

**Solution:** Type the keys **1** **÷** **2** **÷** **3** **ENTER**.



Figure 15

**Answer:** The result is equal to  $1 \div 6$ , in other words the calculation goes from left to right,  $1 \div 2$ , and the result divided by 3. If the calculation went the other way, it would be  $1 \div (2 \div 3)$ , or  $3 \div 2$ , giving 1.5 as the result.

The rules of precedence are that algebraic calculations are carried out in the following order.

1. Expressions in parentheses.
2. All single number functions, also complex number functions, percentages, and co-ordinate transformations.
3. The two-number functions  **$\sqrt{y}$**  and  **$y^x$** .
4. The other two-number functions, **nPr**, **nCr** and **%CHG**.
5. Multiplication, division and integer quotient and remainder, **×**, **÷**, **INT÷** and **Rmdr**.
6. Addition and subtraction.

Operations with the same level of precedence are carried out from left to right, as this example showed.

**Example 6:** In what order is the calculation  $1 + (0.5 + 1.5) \times 3^4$  carried out?

**Solution:** Type the keys **1** **+** **( )** **0** **.** **5** **+** **1** **.** **5** **>** **×** **3** **y<sup>x</sup>** **4** **→** **!** **ENTER**.

ALG  
1+(0.5+1.5)×3^4!  
564,859,072,963

Figure 16

**Answer:** The calculation in brackets is carried out first, giving the result 2. The rest of the calculation proceeds from right to left, as the factorial function has highest precedence, followed by the power function, followed by multiplication, with addition coming last. The answer 564,859,072,963 can be confirmed if 1 is subtracted first, then the result is divided by 2. That result is equal to  $3^{24}$ , which is 3 to the power 4 factorial.

### Example – reusing a previous calculation

A useful feature in algebraic mode is the ability to reuse a previous calculation while changing some of the values in it. The next example illustrates how this would be helpful.

**Example 7:** You wish to perform a calculation involving the gravitational constant, g. You want to add 1 to g divided by three.

**Solution:** Suppose you key in the following.

**1** **+** **↵** **CONST** **ENTER** **÷** **3** **ENTER**

The HP 35s display would show:

ALG  
1+c÷3  
99,930,820,3333

Figure 17

Something tells you there is something wrong. Then you notice that you accidentally used the speed of light, c, rather than the gravitational constant, g. Rather than starting over, you can edit the previous expression and correct your mistake as follows. Press:

**<** **<** **<**

The first press of the left cursor key begins the edit of the previously entered expression. Pressing the left cursor key two additional times places the cursor just to the right of “c” in the expression. At this point, we wish to delete c and replace it with g. Press:

**←** **↵** **CONST** **>** **ENTER** **ENTER**

ALG  
1+g÷3  
4.2689

Figure 18

**Answer:** This example shows how to edit an expression in algebraic mode. While somewhat trivial, it would certainly be easier to edit a much larger expression to correct a mistake than retyping the entire expression all over again.