



hp calculators

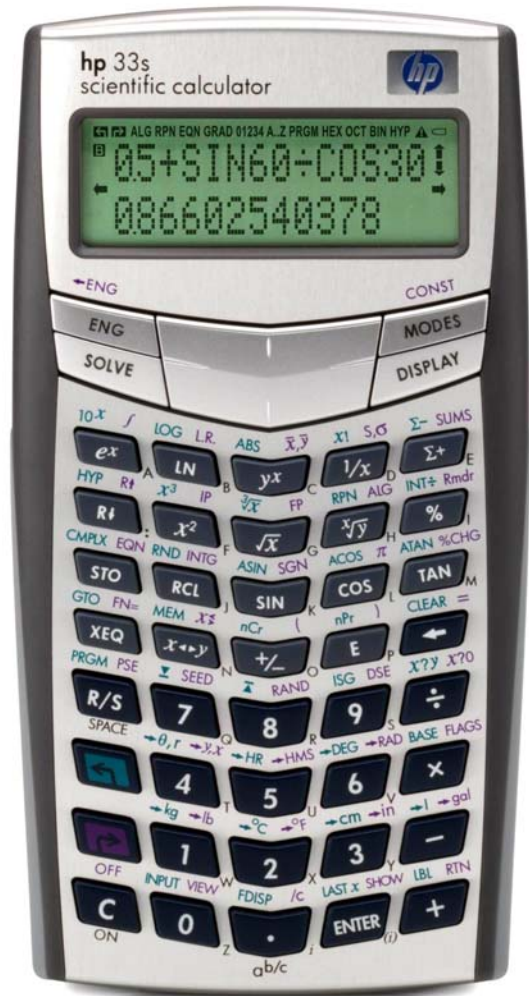
HP 33S Solving for roots

Roots of an equation

Using the SOLVE function

Practice solving problems involving roots

Image of the cursor key area of the HP 33S calculator



Roots of an equation

The roots of an equation are values of X where the value of Y is equal to zero. For example, the equation $Y = X - 2$ has a real root at the value $+2$. The equation $Y = X^2 - 9$ has real roots at the values of $+3$ and -3 . Not every equation has roots that are real numbers. For example, the equation $Y = X^2 + 4$ has no real roots, meaning there are no real values for X that will cause $X^2 + 4$ to equal zero.

Using the SOLVE function

The HP 33S has a very powerful root finding capability built into its SOLVE function. As applied in this training aid, the SOLVE function, accessed by pressing the **SOLVE** key, will be used to find roots from user-written programs computing the value of a function. This will involve entering a small program, keying in a small equation into the program using a variable, indicating to the HP 33S which variable is being considered as the current function, and then solving for the value of that variable when the function is equal to zero. The HP 33S knows which variable to solve for by setting the value of the function under consideration using the **EQN** function. To indicate to the HP 33S that the variable X is to be used, press **EQN** **X**.

This training aid cannot begin to illustrate the wide range of applications available using the built-in solver, but it can illustrate some of the more common uses. For additional information, see chapters 7 and 14 of the HP 33S RPN/ALG Scientific Calculator Owner's Manual.

Practice solving problems involving roots

Example 1: Solve for the roots of $Y = X^2 - 4$

Solution: We're looking for values of X such that $X^2 - 4 = 0$. First, we'll enter a program that computes the value of the function. If a program already exists in program memory with the name of X , then it will need to be cleared. This can be done by pressing **MEM** **→** **ENTER** to have the HP 33S display the list of programs in the calculator and then press **↓** to step through the program labels. When the label of the program to be deleted is shown in the display, pressing **MEM** **CLEAR** will delete that program from the calculator's memory. Pressing **C** will then clear the display and allow you to proceed.

In RPN or algebraic mode: **PRGM** **LBL** **X** **EQN** **RCL** **X** **y^x** **2** **-** **4** **ENTER**
RTN



Figure 1

To show the checksum and length of this program, press the following in RPN or algebraic mode. Note that the symbol **→** means to press the right arrow direction of the cursor key at the top of the HP 33S. If you are unsure of its location, see the image at the end of this training aid.

In RPN or algebraic mode: **MEM** **→** **ENTER** **SHOW**



Figure 2

HP 33S Solving for roots

If the checksum of the program just entered does not equal 9EAF, then you have not entered it correctly. To clear the checksum display press:

In RPN or algebraic mode: \leftarrow **PRGM**

Then, to exit the program environment, press:

In RPN or algebraic mode: \leftarrow **PRGM**

Store an initial guess for X of 10 into the variable X. Then set the function to X and solve for the value of X. Note that the SOLVE function is located on the cursor key area at the top of the HP 33S calculator. If you are unsure of its location, see the image at the end of this training aid.

In RPN or algebraic mode: **1** **0** **STO** **X** \rightarrow **FN** **X** **SOLVE** **X**

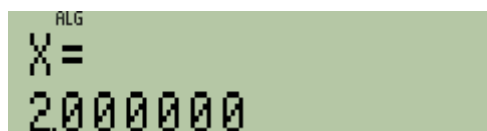


Figure 3

Since you feel this equation has a negative root as well, store a new guess for X of -10 into the variable X. There is no need to set the function to X (since it has already been done). Solve for the value of X.

In RPN or algebraic mode: **1** **0** **+/-** **STO** **X** **SOLVE** **X**



Figure 4

Answer: Roots found for the equation are -2 and +2.

Example 2: Solve for the roots of $Y = X^2 - 7X + 12$

Solution: We're looking for values of X such that $X^2 - 7X + 12 = 0$. First, we'll enter a program that computes the value of the function. If a program already exists in program memory with the name of X, then it will need to be cleared. This can be done by pressing \leftarrow **MEM** \rightarrow **ENTER** to have the HP 33S display the list of programs in the calculator and then press \downarrow to step through the program labels. When the label of the program to be deleted is shown in the display, pressing \leftarrow **CLEAR** will delete that program from the calculator's memory. Pressing **C** will then clear the display and allow you to proceed.

In RPN or algebraic mode: \leftarrow **PRGM** \leftarrow **LBL** **X** \rightarrow **EQN**
RCL **X** **y^x** **2** **-** **7** **x** **RCL** **X** **+** **1** **2** **ENTER**
 \rightarrow **RTN**

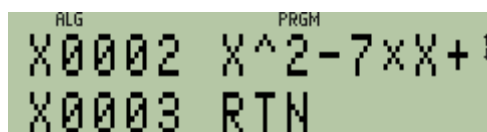


Figure 5

To show the checksum and length of this program, press the following in RPN or algebraic mode. Note that the symbol \rightarrow means to press the right arrow direction of the cursor key at the top of the HP 33S. If you are unsure of its location, see the image at the end of this training aid.

In RPN or algebraic mode: \leftarrow MEM \rightarrow ENTER \rightarrow SHOW

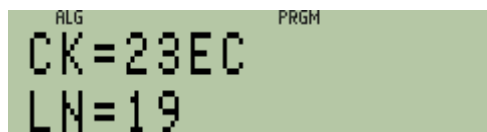


Figure 6

If the checksum of the program just entered does not equal 23EC, then you have not entered it correctly.

To clear the checksum display press:

In RPN or algebraic mode: \leftarrow PRGM

Then, to exit the program environment, press:

In RPN or algebraic mode: \leftarrow PRGM

Store an initial guess for X of 10 into the variable X. Then set the function to X and solve for the value of X. Note that the SOLVE function is located on the cursor key area at the top of the HP 33S calculator. If you are unsure of its location, see the image at the end of this training aid.

In RPN or algebraic mode: 1 0 STO X \rightarrow FN= X SOLVE X

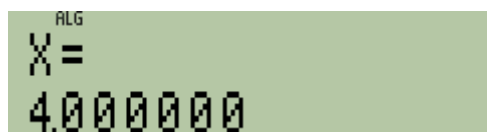


Figure 7

Since you feel this equation might have a root larger than this, store a new guess for X of 100 into the variable X. There is no need to set the function to X (since it has already been done). Then solve for the value of X.

In RPN or algebraic mode: 1 0 0 STO X SOLVE X

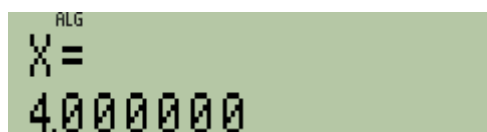


Figure 8

The same root is returned. This is a good indication (but certainly not foolproof) that there are no roots larger than +4 for this equation.

To see if there is a root less than +4 for this equation, store a new guess for X of -10 into the variable X. Then solve for the value of X.

In RPN or algebraic mode: **1 0 +/- STO X SOLVE X**



Figure 9

Answer: Roots found for the equation are +3 and +4. Note that the HP 33S owners manual provides much more information about providing initial guesses for the SOLVE feature.

Example 3: Solve for the roots of $4X^2 - 2X - Y = 12$

Solution: First, rearrange the equation so that the variable Y is isolated. This is necessary to use the SOLVE function as we are doing in this training aid. The rearranged equation is $Y = 4X^2 - 2X - 12$.

We're looking for values of X such that $4X^2 - 2X - 12 = 0$. First, we'll enter a program that computes the value of the function. If a program already exists in program memory with the name of X, then it will need to be cleared. This can be done by pressing **MEM** **→** **ENTER** to have the HP 33S display the list of programs in the calculator and then press **↓** to step through the program labels. When the label of the program to be deleted is shown in the display, pressing **CLEAR** will delete that program from the calculator's memory. Pressing **C** will then clear the display and allow you to proceed.

In RPN or algebraic mode: **PRGM** **LBL X** **EQN**
4 X RCL X y^x 2 - 2 X RCL X - 1 2 ENTER
RTN

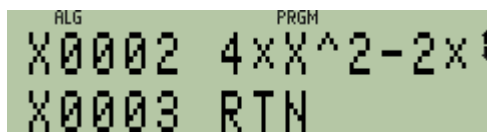


Figure 10

To show the checksum and length of this program, press the following in RPN or algebraic mode. Note that the symbol **→** means to press the right arrow direction of the cursor key at the top of the HP 33S. If you are unsure of its location, see the image at the end of this training aid.

In RPN or algebraic mode: **MEM** **→** **ENTER** **SHOW**

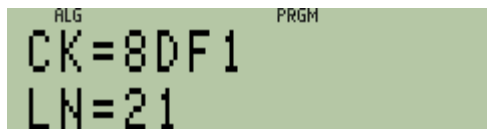




Figure 11

If the checksum of the program just entered does not equal 8DF1, then you have not entered it correctly.

To clear the checksum display press:

In RPN or algebraic mode: **PRGM**

Then, to exit the program environment, press:

In RPN or algebraic mode:  

Store an initial guess for X of 10 into the variable X. Then set the function to X and solve for the value of X. Note that the SOLVE function is located on the cursor key area at the top of the HP 33S calculator. If you are unsure of its location, see the image at the end of this training aid.










In RPN or algebraic mode:         



Figure 12

Since you feel this equation might have a root larger than this, store a new guess for X of 100 into the variable X. There is no need to set the function to X (since it has already been done). Then solve for the value of X.








In RPN or algebraic mode:       



Figure 13

The same root is returned. This is a good indication (but certainly not foolproof) that there are no roots larger than +2 for this equation.

To see if there is a root less than +2 for this equation, store a new guess for X of -10 into the variable X. Then solve for the value of X.

In RPN or algebraic mode:       





Figure 14

Answer: Roots found for the equation are -1.5 and +2. Note that the HP 33S owners manual provides much more information about providing initial guesses for the SOLVE feature.

The next page of the training aid contains a picture indicating the location of the cursor keys and functions used in this document.

Image of the cursor key area of the HP 33S calculator

The arrow by the number 1 indicates the location of the cursor key that should be pressed to move to the right, as indicated by the keystroke .

The arrow by the number 2 indicates the location of the cursor key that should be pressed when the  symbol is found in the instructions.

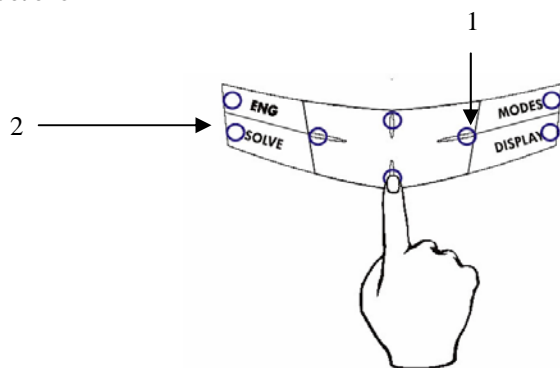


Figure 15