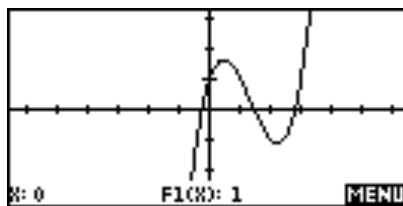
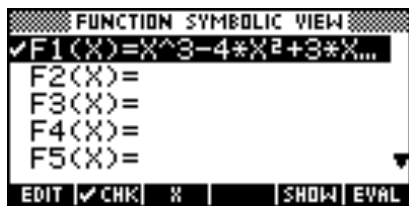


Finding the roots of a graph

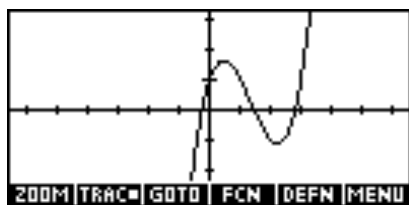
Find the roots of the function $f(x) = x^3 - 4x^2 + 3x + 1$

The process of finding critical features of the graph is done using the Function Tools (FCN) menu.

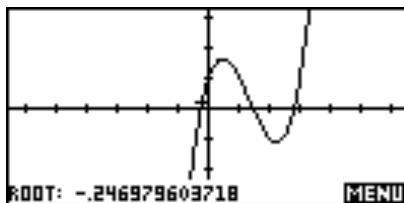
Enter the equation into the SYMB view of the Function applet. Press PLOT.



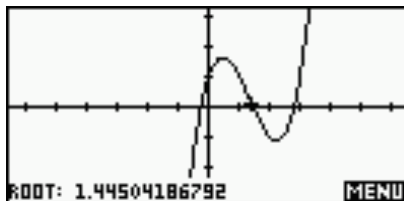
The cursor will initially be on $x = 0$ if you have used the default axes. Press MENU, then FCN (screen key 4) and choose Root from the menu which appears.



The calculator will find the root which is closest to the cursor. In this case, the root is $x = -0.247$.



To find the next two roots, use the right arrow button to move the cursor near to each in succession, pressing MENU, FCN and Root again.



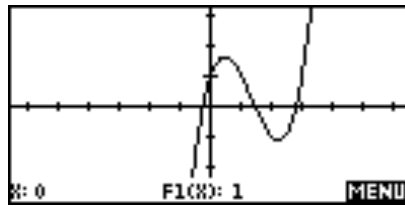
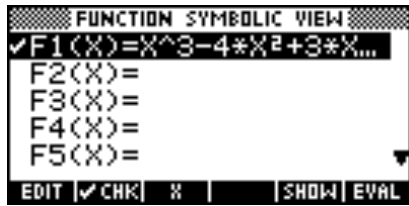
Finding maxima & minima

Find the coordinates of the maximum and minimum of the function $f(x) = x^3 - 4x^2 + 3x + 1$

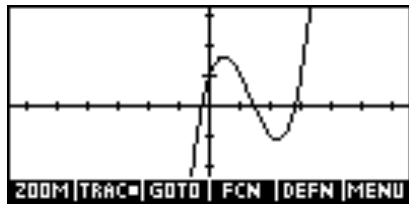
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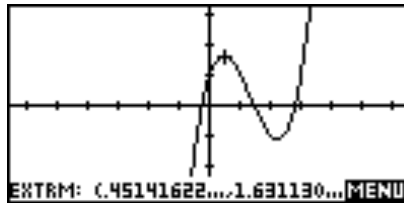
Enter the equation into the SYMB view of the Function aplet. Press PLOT.



The cursor will initially be on $x = 0$ if you have used the default axes. Press MENU, then FCN (screen key 4) and choose Extremum from the menu which appears.



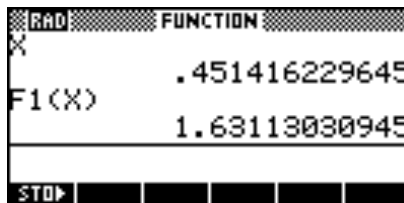
The calculator will find the coordinates of the extremum which is closest to the cursor. In this case at (0.451,1.631).



To find the other extremum, use the right arrow button to move the cursor past the point of inflection so that it is closer to the minimum. Then press MENU, FCN and Extremum again.

It is very easy to access critical points such as roots or extrema in the HOME view or in other aplets. Suppose you have found the maximum of the function as outlined on the previous page and you are now looking at the screen as shown right. If the cursor has been moved then use FCN and Extremum to find the maximum again.

Without moving the cursor, press HOME and use the ALPHA button to enter the letter X. Press ENTER. To find the y coordinate simply enter F1(X) and again press ENTER.



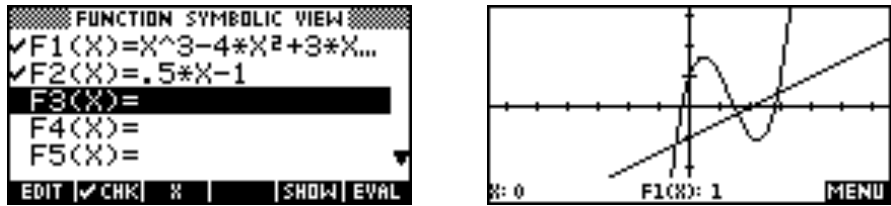
If it is desirable to access these values later or in other aplets then it is best to store them into a variable other than X, since that is over-written each time the cursor is moved or the FCN menu is used.

This same process can also be used for the coordinates found by Root and Intersection from the FCN menu. This is particularly useful when finding signed areas.

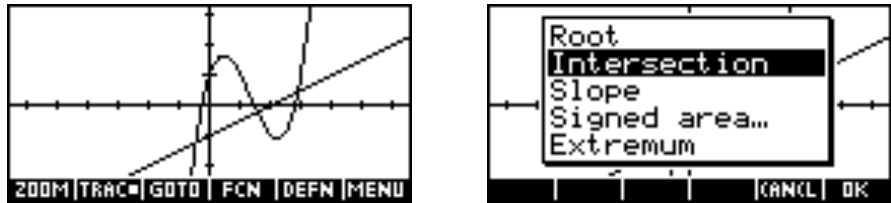
How do I find an intersection?

Find the coordinates of the intersections of the functions
 $f(x) = x^3 - 4x^2 + 3x + 1$ and $g(x) = 0.5x - 1$.

Enter the equations into the SYMB view of the Function applet as F1(X) and F2(X). Press PLOT.



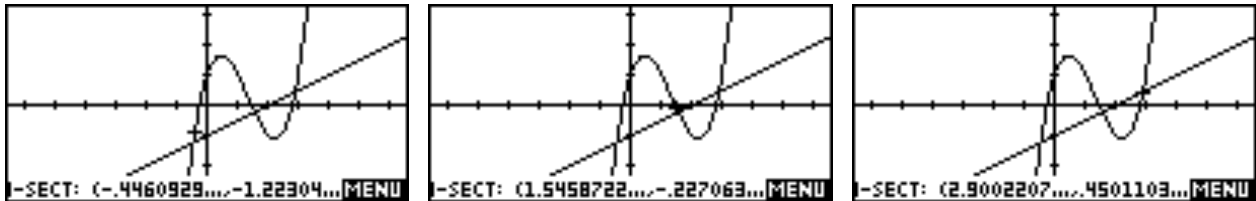
The cursor will initially be on $x = 0$ if you have used the default axes. Press the left arrow four times to move it closer to the leftmost intersection. Now press MENU, then FCN (screen key 4) and choose Intersection from the menu which appears.



At this point you will be asked what function you want to intersect with. The calculator will always start from the function currently being traced and offer a list of all other currently defined functions, plus the x axis.



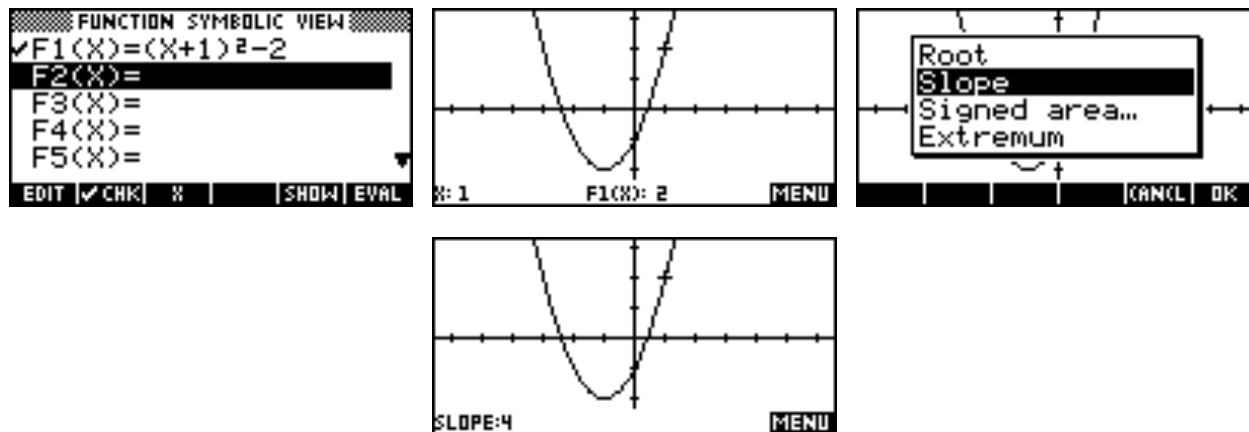
The calculator will find the coordinates of the intersection which is closest to the cursor. In this case at (-0.446,-1.223).



To find the other intersections, use the right arrow button to move the cursor near to them. Then press MENU, FCN and Intersection again.

How do I differentiate a function?

Although there are a number of methods, the slope of a function at a point can most easily be found graphically in the Function applet. Simply PLOT the function, move the cursor to the required point with the arrow keys or with the GOTO button (screen key 4) and then use MENU, then FCN, then Slope.



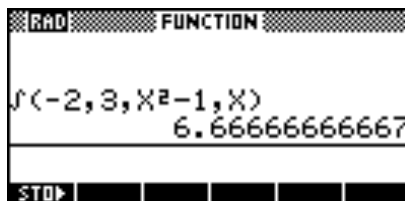
Note that a point does not have to be on screen to be accessible using the GOTO button. Even if the relevant section of the graph is not visible, the same sequence of keys given above will work without any problems.

Integration and areas

There are a number of different methods of finding areas under and between curves. Some are very quick but assume a detailed knowledge of the function. Some are very visual and others combine these features, as can be seen in the following examples.

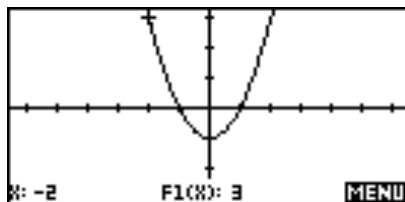
Problem 1: Find the value of the integral of X^2-1 from -2 to 3.

This problem specifies a definite integral and so no consideration needs to be given to whether the function is above or below the x axis. The calculation can be done entirely in the HOME view using the integral function found on the keyboard.



Note that the integration function requires four arguments: The lower limit and upper limit of integration, the equation, and the variable of integration.

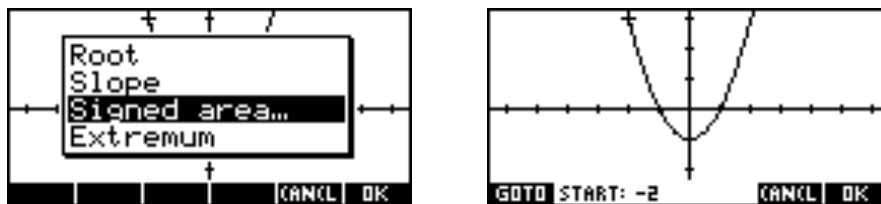
Alternatively we can work entirely in the PLOT view. Enter the function and PLOT it on the standard axes. Now use the GOTO button to move directly to $x = -2$. At this point your screen should appear as shown below.



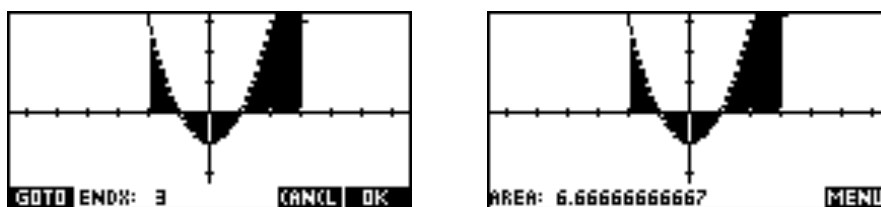
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Now select FCN Signed area... Because we pre-positioned the cursor at -2 the START: value initially displayed will be correct. Press ENTER.



The calculator will now ask for an END: value. Rather than using the GOTO button, press right arrow repeatedly (or press and hold). As you do the integral being calculated will be shaded. While it does, watch the value at the bottom of the screen and stop when it reaches $x = 3$. Press ENTER to see the same result as was found in HOME.



Notes:

1. Although the shading may give the impression that an area is being calculated this is not the case. The value given is the definite integral not the area. This is the reason why the FCN menu uses the term "Signed Area..." instead of "Area".
2. The process can be made considerably faster if the GOTO button is used to move to the END point. However, if this is done the region will not be shaded.
3. You may not be able to reach the precise required value if the scale you've chosen doesn't allow it. If so, move near the value and use GOTO.
4. The value of the last integral performed in the PLOT view can be recalled in the HOME view by typing AREA. As explained above, it should be remembered that this is not necessarily a true area.