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Calculator Lesson 3

Introduction to Graphing

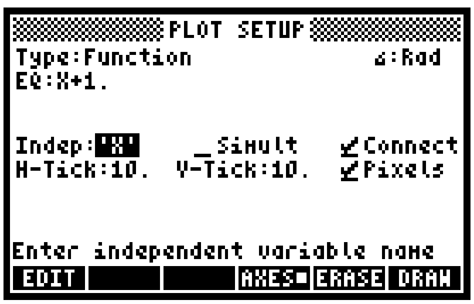
Graphs provide a powerful tool for analyzing functions, and good graphing technologies, such as the HP-50g, provide a powerful tool for creating graphs. Like all technologies, however, one must learn how to use them effectively and one must learn to deal with their inherent limitations. This lesson will introduce the basics of graphic commands on the HP-50g. More information can be found in Chapter 10 of *User's Manual* and Chapter 12 of *User's Guide*.

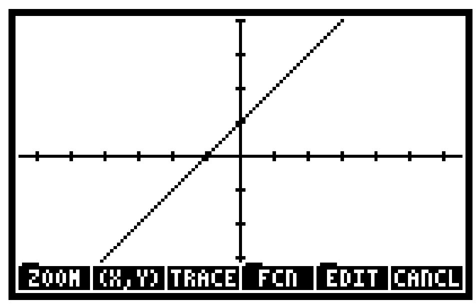
If you have variables PPAR, EQ, or ZPAR in your variable list, delete them before you continue so that your calculator will behave as this lesson indicates it should. See Lesson 1 for instructions on purging variables.

The first function we will graph is the line $y = x + 1$. Press

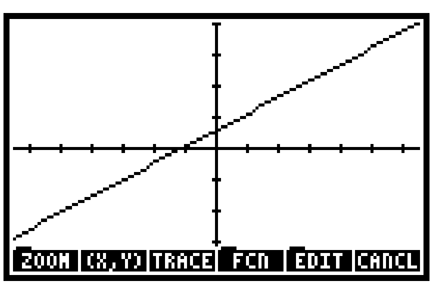
LS(hold) F4-2D/3D DA ' X + 1 F6-OK.

The dialog box should now look like the figure below on the left.





Now press F5-ERASE F6-DRAW and the line appears in the default plot window as seen in the figure above on the right. Suppose we want to choose a different window. Press CANCEL twice to get back to the normal screen then press LS(hold) F2-WIN to get into the PLOT WINDOW dialog box. The H-View line is telling us that in the horizontal direction the window goes from X = -6.5 to X = 6.5. The V-View line is telling us that in the vertical direction the window goes from Y = -3.9 to Y = 4. Notice that the screen appears to be a little less than twice as wide as it is high, and the X range of the window is a little l than twice its Y range. This insures that the units on both axes are the same so geometric properties are preserved. For example, we saw that the line we drew appeared to cross the axes at 45^0 as we would expect it to. Frequently, however, seeing the whole range for the chosen domain is more important than maintaining the geometric properties. Press F4-AUTO. Note that the Y range is now -7.45 to 7.5. If we now press F5-ERASE and F6-DRAW, we see all of the line for the given X range as shown in the figure to the left. Notice that the line no longer crosses the x-axis at 45 degrees.



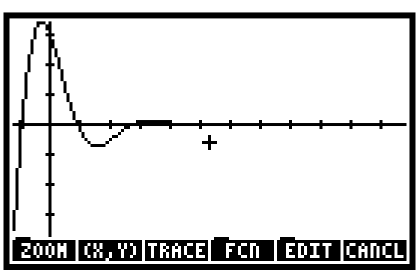
Press CANCEL to get back to the window dialog box. With Low: and High: set to default in the Indep line, the calculator will plot over the same domain of the independent variable as given in the H-View line. There are times when we may not want to plot over that entire X-range of the window. Use the arrow keys to move the cursor to Low: and enter a -4, then to High: and enter a 5. Do ERASE and DRAW again and we see that the line has been graphed only on the domain we specified.

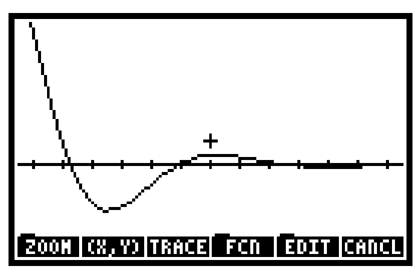
We also note that the tick marks on the y-axe do not seem quite right. It looks like the graph crosses the y-axis at .5 instead of at 1. To deal with that, we need to return to the 2D/3D dialog box. Press CANCEL twice then LS(hold) F4-2D/3D. The bottom set of fields on the screen are for the tick marks. The HP default is to set tick marks every 10 pixels in each direction. With the default window, these are one unit apart. If we choose to have them 1 unit in each direction, set H-Tick and V-Tick each to 1 and uncheck Pixels. Now do ERASE and DRAW again and the tick problem is fixed.

In Lesson 2 we suggested using the table to explore the behavior of the polynomial function $y = Ax^2 + Bx + C$ for various values of the parameters. Let us see how we can do this graphically. In the 2D/3D dialog box press NXT F1-RESET DA F6-OK to set all the fields in this dialog box back to their default status. Now enter 'P(X)' for the equation then press NXT F6-OK to accept these settings for the box. Let us set *A* to 1 and *B* and *C* both to zero. Now go into the WIN dialog box and reset it to its defaults the same way we did it in the PLOT SETUP dialog box then NXT, ERASE and DRAW, and you should see a parabola that opens up with the vertex at the origin. Now CANCEL twice, change *B* to 1 and press LS(hold) GRAPH. A new parabola appears a little to the left and below the previous one. (This could also have been accomplished from WIN or 2D/3D by pressing DRAW without the ERASE.) Press CANCEL, pick a new value for one of the parameters, and LS(hold) GRAPH again to see how the graph changes.

Now let us look at the function

$F(X) = \dfrac{\cos(X)}{e^{x/2}}$ we discussed in Lesson 2. In 2D/3D change the EQ: to 'F(X)' then NXT OK and get into WIN. Set the H-View from -2 to 20 and the V-View to Auto then ERASE and DRAW. We see, in the figure below on the left, that the





function seems to become identically zero after the forth tick mark to the right of the origin. To get a better picture, we will zoom in on that area. Press F1-ZOOM then F1-ZFACT. Set the H-Factor to 2, the V-Factor to 50, and check Recenter on cursor. Press F6-OK then use the arrow keys to set the cursor on the x-axis at the 7th tick to the right of the origin and press F3-ZIN. We now have a better picture (figure on the right above) of what is happening in that part of the graph. If we were not happy with this zoom, we could press F1-ZOOM NXT NXT F4-ZLAST to get back to our original graph and try different zoom factors and/or a different location for the cursor before zooming.

In Lesson 2 we found a point between 0 and 1 where P(*X*) and F(*X*) were equal. We will now try it graphically. We had the parameters for P set to *A* = 3, *B* = 1, and *C* = -1, so set them that way again. In 2D/3D set the equation to {'P(X)' 'F(x)}, in WIN set the window to the default, and ERASE and DRAW. We see that the graphs cross between 0 and 1, so they are equal at that point. Use the arrow keys to put the cursor over that point then press F2-(X, Y). We see in the lower left corner of the screen that the X coordinate is .6. Press + to get the menu back then press F1-ZOOM. Move the cursor a little to the left and below the intersection, press F2-BOXZ, move the cursor a little above and to the right of the intersection, creating a box that contains the intersection. Press F6-ZOOM and the graph in the box is expanded to fill the screen. Move the cursor again to the point of intersection and press F2-(X, Y). The value you get will vary slightly depending on exactly where you put the box, but it should be between .58 and.59. Repeat the procedure and you should get .587. Repeat and we see .587 again. We seem to have gotten as close as we can, but not so! Press ENTER, then repeat and press ENTER again with the (X, Y) showing. Now press CANCEL twice to get back to the stack and we see a set of coordinates on level 2, from the first ENTER, and on level 1 from the second. We see that the second *X* value is closer to the solution than the first. It would now seem that we can do this as many times as we want and get any desired level of accuracy. Not so!. We are still dealing with a finite machine with limitations in precision. The method is sure to break down eventually.

Try the same method to find the intersection near *x* = -1.

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