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## Calculator Lesson 2

### Functions and Tables

In this lesson we will learn to use the equation writer, we will learn how to define a function and we will learn how to create a table of values for a function. More information on these topics can be found in chapters 2, 3 and 10 of *User's Manual* and chapters 2, 3 and 12 of *User's Guide*.

To enter the equation writer press RS EQW. We will create the expression

$$\frac{e^{X^2+1} - 2}{\sqrt{mX^2 + 3} - 4} + 5.$$

Enter the equation writer and type the following sequence. Keep a close eye on what is happening in the equation writer.

```
LS ex X Yx 2 RA + 1 RA RA - 2 RA RA ÷
√X AS LS M × X Yx 2 RA RA + 3 RA RA - 4 RA RA RA + 5 ENTER
```

Do you see what the RA's in the sequence are doing? If you still question their purpose, try leaving some out and see what happens. There are more complex expressions that require the use of UA instead of RA. We could have used UA in place of RA above, but it would have taken more of them. Try it! To see an example for which UA must be used, see Lesson 14.

The calculator has many built in functions, but there are times when we want to work with one that is not built in. The calculator gives us the tools to build our own functions. Let's define the function

$$F(X) = \frac{\cos(X)}{e^x}.$$

Get into the equation writer and type:

```
AS F LS ( ) X RA RS = COS X RA
÷ LS ex X ENTER.
```

Now press LS DEF to define the function. If you look at your variables, (press VAR if necessary), you will see that the left most soft menu label is now F. To evaluate this function for any particular value of X put the value of X in the command line or on level 1 of the stack and

press F1-F. For example  $F(0) = 1$  and  $F(.5) = .532280730215$ . To see what this function looks like after it has been defined, press RS F1-F. You should see

<< → X 'COS(X)/EXP(X)' >>

on level 1 of the stack. This is actually an HP program. If you want to learn more about programming return to the list of lessons and click on “An Introduction to Programming HP Graphics Calculators” near the bottom of the page.

Suppose you wanted to make a change to this program. Let's change the denominator to  $e^{X/2}$ . Delete the copy of the function from the stack and press ' AS F ENTER LS DA. This puts a copy of the function in the command line. Use RA to move the cursor to the right of the X in the denominator then type

÷ 2. To make the change permanent, press ENTER. If you decide against the change, press CANCEL. If you pressed ENTER, and evaluate  $F(.5)$  again you will get .683461986409.

For a different example, suppose you would like to explore the behavior of the quadratic polynomial  $P(X) = AX^2 + BX + C$  for various values of A, B and C. Enter the equation writer and type

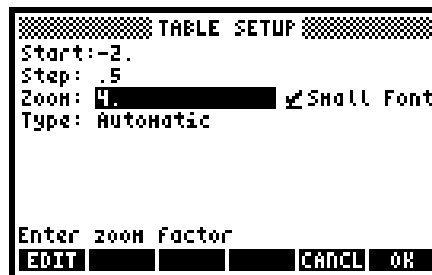
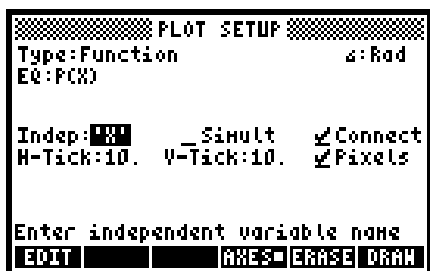
AS P LS ( ) X RA RS = AS A × X Y<sup>X</sup> 2 RA RA + AS B × X + AS C ENTER.

Now press LS DEF to define the function. Before we can execute this function, we must define the parameters A, B and C. Create and store values for the parameters as we did for the variable TAX in Lesson 1. With all three set to 1,  $P(2) = 7$ . Change A to 3 and now  $P(2) = 15$ . Now change C to -1 and  $P(2) = 13$ .

It is frequently helpful to look at a table of a function. The following will give us a table of  $P(X)$  starting at  $X = -2$  in steps of .5. Press LS(hold) 2D/3D to get into the PLOT SETUP dialog box. The Type: line should read Type:Function. If it doesn't, press AS F once or twice as needed to fix it. Use DA to go to the EQ: line and press

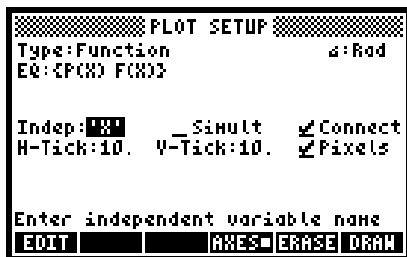
' AS P LS ( ) X F6-OK.

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



Now press NXT F6-OK then press LS(hold) TBLSET to get into the TABLE SETUP dialog box. Set Start: to -2, and Step: to .5. The dialog box should look like the figure on the right above. Press F6-OK then press LS(hold) TABLE and we see the table. The table is actually infinite in

both directions; you can use UA and DA to get to any point in the table. Suppose you are only interested in seeing the values of the function for integer values of X. Press F1-ZOOM, use DA to get to Integer, then press F6-OK. We now see the values of the P(X) evaluated at the integer values. Press CANCEL to get back to normal calculator operation.



Now suppose we want to compare our two functions, F and P. Get back into the 2D/3D dialog box and change EQ: to {'P(X)' 'F(X)'}. The dialog box should now look like the figure to the left. Now press NXT F6-OK, then LS(hold) TABLE gets us back into the table. Because we listed P before F, the Y1 column has the P values and the Y2 column has the F values. We see that  $P(0) = -1 < 1 = F(0)$  and  $P(1) = 3 > .328 = F(1)$ , which tells us that there is a point between 0 and 1 where P and

F are equal. We would like to get an approximation for that point. With the cursor on 0, press F1-ZOOM, use DA to get to Decimal, then press F6-OK. By using DA to scroll down a bit we see that  $P(.5) < F(.5)$  and  $P(.6) > F(.6)$ , so the point of equality is between 0.5 and 0.6. We would like to zoom in closer by factors of 10, so press CANCEL, get into TBLSET, and change Zoom: to 10. Now press F6-OK and go back into TABLE. With the cursor on .5, press F1-ZOOM. It is already selected, so press F6-OK. We scroll down again and see that the equality point is between 0.58 and 0.59. With the cursor at .58, zoom in again and we see the equality point is between .587 and .588. Repeat three more times and we can see that the equality point is between 0.587023 and .587024. That's the best we can do at this point. Since the values are closer to being equal at .587024, we could choose that as our approximation for the point where  $P(X) = F(X)$ .

If you now check your variables you will find that there are three you did not create, TPAR, EQ, and PPAR. These were created by the HP-50g to do its work. It is generally a good idea to purge these variables (as discussed in Lesson 1) if you want your calculator to behave like new next time you use it. If you do not purge these variables, the next time you open one of the dialog boxes we used this lesson they will look as they did the last time you used it.

Experiment with some of the other options in the dialog boxes that were discussed in this lesson, and read the appropriate sections of *User's Manual* and *User's Guide* listed at the beginning of the lesson to find other interesting things you can do.

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