CHAPTER 3  Calculator Notes for the TI-83 Plus and TI-84 Plus

Note 3A • Entering and Graphing Equations

Equations are entered into the Y= screen for various purposes, including graphing. You can enter up to ten equations, Y1 to Y0.

Entering Equations

Make sure you are in Function mode. Press [MODE]. In the fourth line select Func, then press Y/. Enter an equation. The variable must be X using the [X,T,θ,n] key. You can edit an equation by using the arrow keys and [DEL] or [2nd] [INS]. To remove an equation from the Y= screen, highlight it and press [CLEAR].

Before actually graphing, you’ll need to determine which part of the Graph screen you want to view.

Setting the Window

Press [WINDOW] and enter these values.

- Xmin = the minimum x-value you want displayed.
- Xmax = the maximum x-value you want displayed.
- Ymin = the minimum y-value you want displayed.
- Ymax = the maximum y-value you want displayed.
- Xscl = and Yscl = the number of units between tick marks on each axis.
- If there are too many tick marks, individual marks won’t be distinguishable and the axes will appear too thick.

Xres = 1.

Graphing

Press [GRAPH] to see the graph of the equation(s). They will appear one after another, in the order listed on the Y= screen.

If the graph is not situated on the screen to your satisfaction, go back to the Window screen and change the values. Experiment with various window settings until you’re satisfied with the appearance of the graph.

You can turn off the graph of an equation without clearing it from the Y= screen by arrowing to its = symbol and pressing [ENTER]. When the = symbol is not highlighted, the equation is turned off and will not graph.

(continued)
Tracing
You can find approximate coordinates of points on the graph by tracing. Press \text{TRACE} and a "spider" appears on the first graph. Use the left and right arrow keys to move it along the graph. The coordinates of the spider’s position appear at the bottom of the screen. You can move to the graphs of other equations by arrowing up or down.

Notation on the upper-left part of the screen tells you which equation’s graph is being traced.

Zooming
There are several ways to enlarge part of the graph. You can go back to the Window screen and change the window settings, or you can choose one of the commands that appear when you press \text{ZOOM}.

1:Zbox allows you to define your own enlargement. Select 1:Zbox to display a spider. Use the arrow keys to move the spider to the area you’d like to enlarge. (This spider isn’t restricted to the curve the way the trace spider is.) Press \text{ENTER}. Then draw a box by arrowing to the corner diagonally opposite from your current position. Press \text{ENTER} again. The interior of the box will enlarge and fill the screen.

2:Zoom In enlarges the screen by a factor of 4. Selecting 2:Zoom In will display a spider that you can position to where you want the center of your new enlarged screen. Press \text{ENTER} to see the new screen.

3:Zoom Out does the opposite of Zoom In. Select 3:Zoom Out, position the spider to the desired screen center, and press \text{ENTER} to see the new screen.

Zooming automatically changes the settings on the Window screen.

Graphing a Line and a Plot
You can graph a line over a plot by entering the equation into the \text{Y=} screen and the plot as directed in \textbf{Note 1F}. If you trace, arrowing up or down causes the spider to jump to each plot and to each function in order.
Note 3A • Entering and Graphing Equations (continued)

Setting the Graph Style
In order to distinguish between several displayed graphs or to achieve a special effect, it is sometimes helpful to use a graph style other than the usual thin, solid line.

Use the left arrow key to highlight the style symbol to the left of $Y_1$ and repeatedly press [ENTER] to cycle through the various styles. These examples show the possible styles.

$Y_1$ graphs a curve using the usual thin, solid line. This is the default setting.

$Y_2$ graphs a curve using a thick, solid line.

$Y_3$ shades the area above the curve.

$Y_4$ shades the area below the curve.

$Y_5$ shows a moving circle that follows the curve and leaves a path.

$Y_6$ shows a moving circle that follows the curve but leaves no path (not shown on the screen here).

$Y_7$ graphs a curve using a dotted line.

Note 3B • Function Tables
You can build a table of values for any function entered into the $Y=$ screen. Press [2nd][TBLSET].

TblStart = the first $x$-value you wish to see in the table when first viewed.

$\Delta \text{Tbl} = $ the difference between the $x$-values in the table. In the first screen here $\Delta \text{Tbl}=1$, so the difference between successive $x$-values is 0.1. $\Delta \text{Tbl}$ can be negative.

Indpnt: set to Auto means that the table will automatically start with the $x$-value equal to the TblStart value. If Indpnt: is set to Ask, the table will be blank until you provide the $x$-values.

Depend: should always be set to Auto.

(continued)
Note 3B • Function Tables (continued)

Press \[2nd\] [TABLE] to display the table.

If Indpnt: is set to Auto on the TABLE SETUP screen, you can arrow up or down to see more \(x\)-values. You can also arrow right to see values of other functions that are turned on in the \(Y=\) screen. You can see only two columns of dependent variables at a time.

If you arrow up to the top of a function column, you can see the equation displayed at the bottom of the screen. Press \[ENTER\] to edit the equation. The changes will be reflected in the table when you press \[ENTER\] again.

Note 3C/App • Balloon Blastoff Using the EasyData App

You will need a CBR2 (Calculator-Based Ranger).

Connect the CBR2 to the calculator. Press \[APPS\] and select EasyData. The CBR2 will immediately begin collecting distance data, which are displayed on your calculator screen. However, you need to collect data at shorter intervals for this experiment. Press \[Setup\] (\[WINDOW\]) and make sure \(1:Dist\) is selected. The calculator will ask you to confirm, so press \[OK\] (\[GRAPH\]).

Aim the CBR2 at the rocket and press \[Start\] (\[ZOOM\]). The CBR2 will collect data for about 5 seconds. If you want to stop it sooner, press the trigger. The calculator will display a graph of your data, which you can trace using the left and right arrow keys.

If you need to redo the experiment, press \[Main\] (\[TRACE\]), then press \[Start\] (\[ZOOM\]). You will be told that this function will override the previous data. Press \[OK\] (\[GRAPH\]) and repeat the steps above.

To end the application, press \[Main\] (\[TRACE\]), then press \[Quit\] (\[GRAPH\]). You will get a message telling you where the data are stored. Time data are in \(L_1\), distance data are in \(L_6\), velocity data are in \(L_7\), and acceleration data are in \(L_8\).
Note 3D • Median-Median Line

The calculator can find the equation of the median-median line for a set of data. Press \( \text{STAT CALC} \ 3: \text{Med-Med} \), then enter the two lists that contain the data, separating them with a comma, and press \( \text{ENTER} \). The independent variable list should be first. The command’s default is to use lists \( L_1 \) and \( L_2 \), but it is a good habit to always specify the lists to be used.

If you want the equation placed in \( Y_1 \) on the \( Y= \) screen, after the second list press \( \text{VARS} \ \text{Y-VARS} \ 1: \text{Function...} \ 1: Y_1 \ \text{ENTER} \).

Note 3E • Residuals and the Root Mean Square Error

Once you have found a model for paired data, you can calculate the residuals and then the root mean square error.

For this example, assume that your data are stored in lists \( L_1 \) and \( L_2 \) and your equation is stored in \( Y_1 \).

Residuals

a. Press \( \text{STAT} \ \text{ENTER} \).

b. Move to the name cell at the top of list \( L_3 \). Define list \( L_3 \) as the residuals by entering the expression \( L_2 - Y_1(L_1) \). To get \( Y_1 \), press \( \text{VARS} \ \text{Y-VARS} \ 1: \text{Function} \ 1: Y_1 \). The resulting list will not change if you change the data in list \( L_1 \) or list \( L_2 \) or the equation in \( Y_1 \). If you want this list to be dynamic (changing when list \( L_1 \), list \( L_2 \), or \( Y_1 \) changes), enter the expression within quotation marks using \( \text{ALPHA} \ ["] \).
Root Mean Square Error

The root mean square error is defined as

\[ s = \sqrt{\frac{\sum_{i=1}^{n} (y_i - \hat{y}_i)^2}{n - 2}} \]

The numerator of the fraction is the sum of the squares of the residuals. The denominator is 2 less than the number of elements in list \( L_3 \).

a. First calculate the residuals in list \( L_3 \) as described above.

b. Calculate the numerator of the fraction and the value of \( n \). Press \( \text{STAT} \) \( \text{CALC} \) 1:1-Var Stats \( 2nd \) \([L_3]\) \( \text{ENTER} \). This puts the sum of the squares of the residuals into a variable called \( \Sigma x^2 \) and the number of elements in the residual list into a variable called \( n \).

c. Enter this formula into the Home screen: \( 2nd \) \( \Sigma \) \( \text{VAR} \) 5:Statistics:... \( \Sigma 2\Sigma x^2 \) \( \text{VAR} \) 5:Statistics 1:n \( \text{VAR} \) 5:Statistics \( \text{ENTER} \). The result is the root mean square error.

For large values of \( n \), you can find a good approximation by dividing \( n - 1 \) instead of \( n - 2 \). This is the sample standard deviation of the residuals, or the value of \( S_x \) when you do 1-Var Stats.

Note 3F • Greatest Integer Function

To find the greatest integer less than or equal to a value, press \( \text{MATH} \) \( \text{NUM} \) 5:int(, enter the value, and then close the parentheses. If the value is a positive decimal number, the function truncates everything after the decimal point; if the value is a negative decimal number, it does the same and then subtracts 1.

You can also use \( \text{int} \) as a function of \( x \). When graphing this function, the calculator may show almost-vertical segments that shouldn’t be there. You can eliminate them by changing the graph style to a dotted line. (See Note 3A for help setting the graph style.)