

# Chapter 0

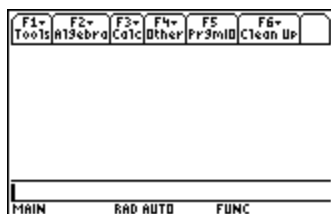
## Overview of the TI-89 (TI-92 Plus, Voyage 200)

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- §1. Settings, Layout, Operating Systems, Desktop
- §2. Home Screen Operations
- §3. Functions, Tables, and Graphs
- §4. Entering Data, Performing a Regression
- §5. Solving Equations
- §6. Programming
- §7. Saving Your Work in a Text File
- §8. Units
- §9. Connecting to a Computer, Other Applications

This chapter provides a brief introduction to some of the features of this family of graphing/symbolic calculators that relate to pre-calculus material. For the most part, we demonstrate with the TI-89, which is the most common choice for students at WMU. The TI-92 Plus (no longer made) and the Voyage 200 provide the same capabilities in a larger-sized model with a QWERTY keyboard. If you have not already purchased your calculator, you might want to consider the Voyage 200. For only about \$50 more, you get more memory, several cost applications, a larger keyboard and screen, and the GraphLink cable to connect to your computer. The newest TI-89 Titanium comes with more memory and a direct USB connection.

### 1. Settings, Layout, Operating Systems, Desktop



TI-89 Home Screen

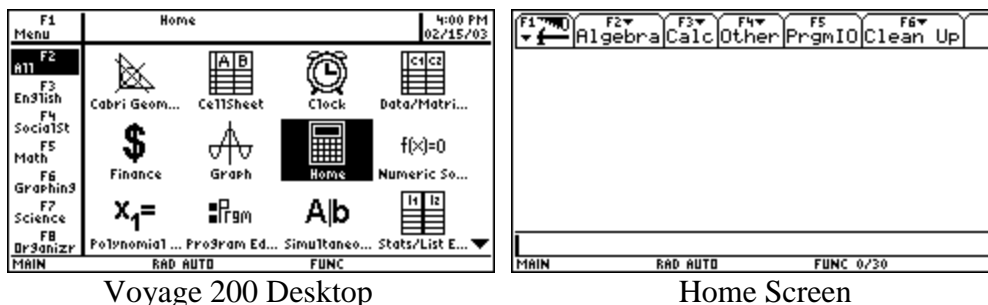


Applications List



Mode Settings

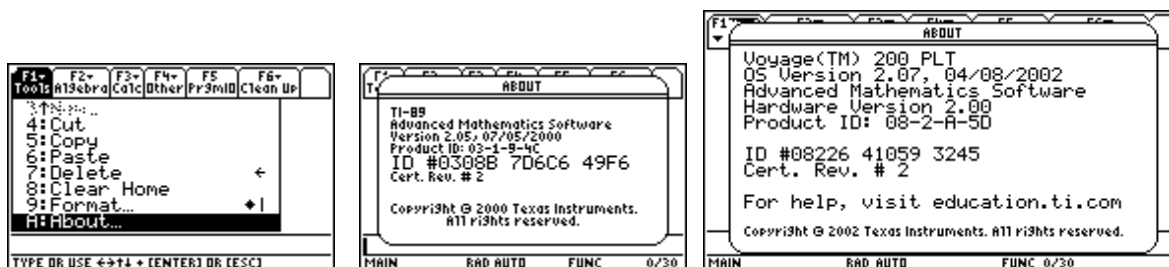
When you press the ON button (lower left), a TI-89 generally comes on in what is called the HOME screen as in the first figure above. You will do immediate computations in the command line at the bottom of the screen. Results will appear in the middle region, which is called the “history” area, and many commands can be obtained by pressing one of the function keys F1-F8, which are blue keys below the screen. The different “screens” of the calculator are called applications. Press the blue APPS key to bring up the list of applications as in the second figure above. Note that additional applications can be loaded into the calculator, and they will appear under the heading 1:FlashApps. Press the MODE key to bring up the first page (of three) of various settings for the calculator.



A Voyage 200 generally comes on with an icon desktop displaying the applications. This can be turned off in a page 3 mode setting, but it includes a possible clock in the corner which is nice. Press ENTER with an icon highlighted to move to that application. As you see in the figure above, the Voyage 200 comes with some additional flash applications (most of which can be added to a TI-89). The APPS key brings you back to the icon desktop.

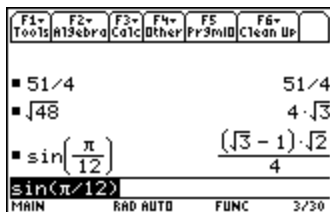
You adjust the contrast of the screen by holding the green “diamond” key and pressing the “+” key to darken and the “-” key to lighten. If you need to keep increasing the contrast, this is a sign that your battery is low. A low battery signal will also come on as a warning and certain linking operations will not be allowed when the battery is low.

This family of calculators uses flash ROM, enabling all of the code in the calculator to be upgraded. Texas Instruments calls the software running the calculator the operating system or OS. You can check at the TI web site (<http://education.ti.com>) for the newest OS version and for new applications available for downloading. You will need a computer and the GraphLink cable to download new things from the web site. You can also get a new OS and free applications from another calculator (of the same model). Press F1 A: About to see what version you have.



The ESC key is very important for escaping out of some situation. If you pull up a menu and decide *not* to select anything, press ESC to back out of the menu (or submenu). In many situations, the display will give you the option to ENTER to save or confirm and ESC to cancel out of that process. For example, none of the changes you make in the MODE pages take effect until you press ENTER=save, with ESC=cancel as an option.

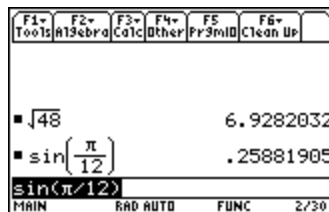
## 2. Home Screen Operations



ENTER in AUTO

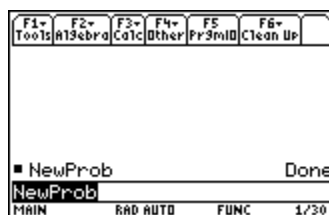
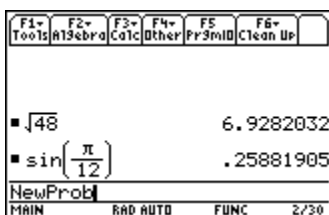
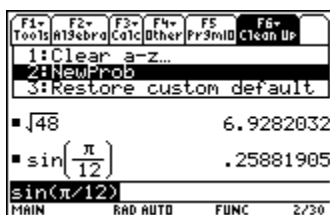


◆ENTER in AUTO

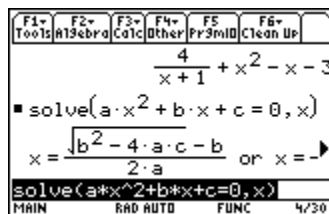
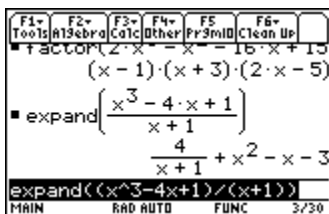


The default Exact/Approx mode setting is AUTO, and this allows many computations to be done exactly. The command F1 8:Clear Home erases the “history” area. When you want a decimal approximation in this mode setting, just press the “green diamond” key before the ENTER key to get “APPROX ≈”, rather than changing the mode setting.

Notice below the command line some of the mode settings are displayed. In the figures above, the MAIN indicates we are in the main folder, RAD indicates radian angle mode, AUTO indicates the exact/approx mode, FUNC indicates function graphing is selected, and the 3/30 in the first two figures indicates that the history contains 3 items out of the 30 that will be remembered (with more or less possible as a format setting).



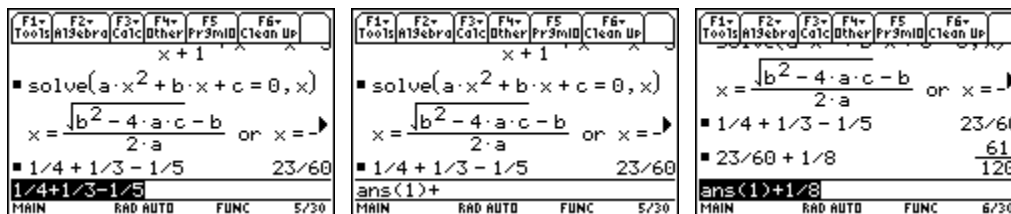
Variable names can be up to 8 characters long and must begin with a letter. Usually we use single letter names for true variables in our algebraic expressions, and we use longer names for programs and other things we wish to keep. The F6 2:New Problem command is a very nice way to start fresh. It clears the history, clears out all variables named by a single letter (as does F6 1:Clear a-z...), and deselects all functions and plots in graphing.



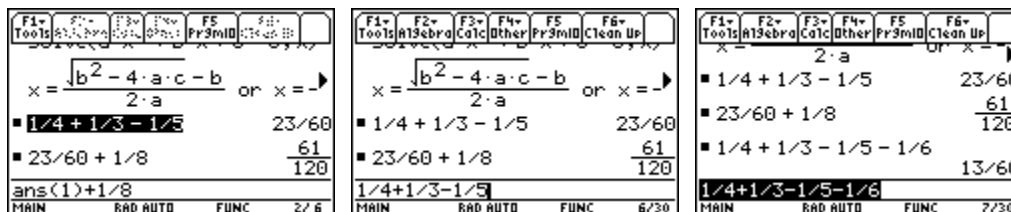
Notice in the first figure above, we have used “implied multiplication” when we typed the coefficients of the polynomial. In the last figure, we needed the multiplication symbol between “a” and “x” and between “b” and “x” because typing “ax” and “bx” would have been interpreted as new variable names.

You notice that after you press ENTER, the last command stays in the command line, but it is all highlighted. If you simply start typing, the new typing replaces the highlighted expression. If, instead, you want to edit the last line, press the left or right cursor keys to move the insertion

point to that end and remove the highlighting. Then you can edit the expression. The “back arrow” ← key is a destructive backspace command. Above that key, the command “green diamond” DEL above the back arrow is a destructive forward movement. By default, any typing that you do is inserted where the blinking vertical bar appears in the command line. Pressing 2<sup>nd</sup> INS above the back arrow is a toggle converting between the insert entry mode and the typeover entry mode (blinking space).



After entering a command (as in the first figure above), you can simply press “+” to do a continuation calculation. If you press any command requiring an argument before the command (like “+”), the calculator assumes you wish to use the last answer. In the second figure, we see it has added “ans(1)” in front of the “+” that we typed to indicate this. When you want the last answer (and any one stored in the history) somewhere else in the command line, use ANS (above the negation key). Just edit “ans(1)” to have another number if you want to go back more than one answer.



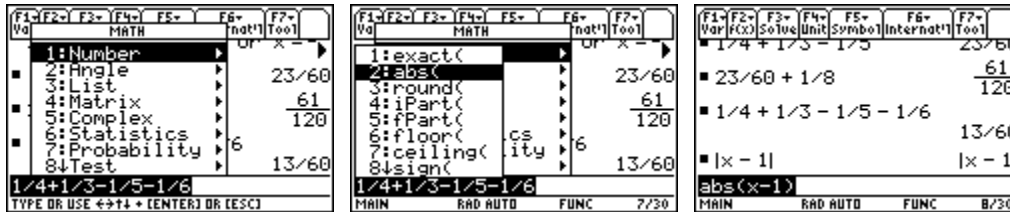
When you use the up cursor, you move up into the history area and highlight results (on the right) and command lines (on the left by a ■). You sometimes must do this to scroll sideways to read all of a long result. Pressing ENTER while something in the history is highlighted causes it to be pasted into the command line as figure one and two above. Thus you should never need to retype anything you can see!! While the cursor is anywhere in the history area, you can press ESC to jump down to the command line without pasting anything there.

Holding the “up arrow” ↑ key and then cursoring in the command line allows you to selectively highlight a part of the command line. Under F1 Tools, you will find that you have Cut, Copy, and Paste much like on a computer.

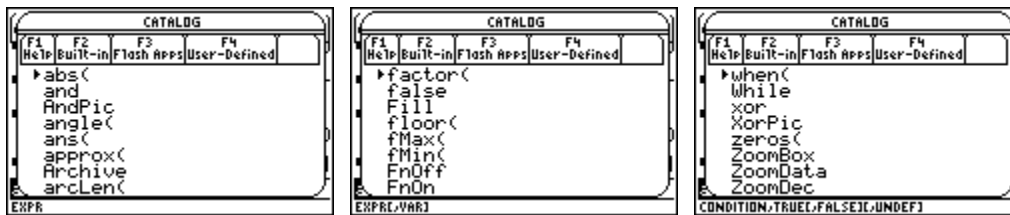


Some Default TI-89 Custom Menu Items

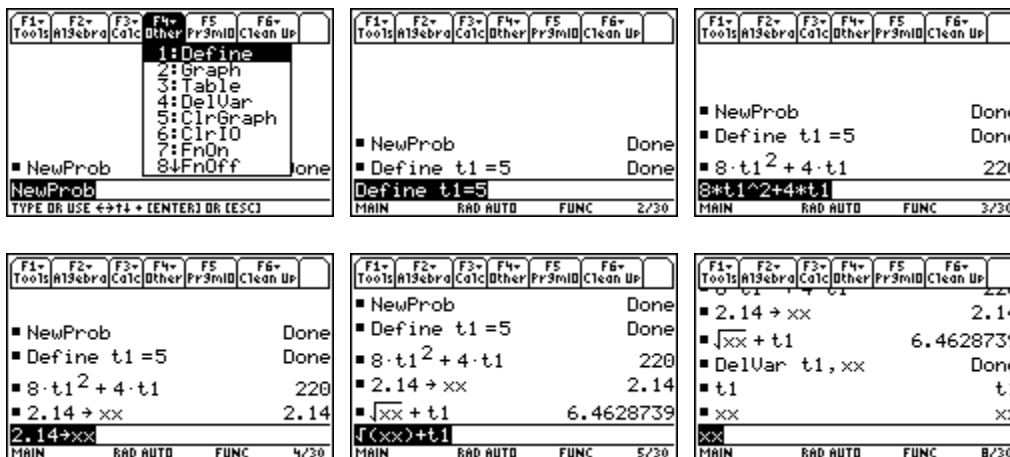
Since it is a little hard to type long phrases on the TI-89 (with no QWERTY keyboard), this calculator is provided with a default CUSTOM menu providing phrases and symbols commonly used. Pressing 2<sup>nd</sup> CUSTOM toggles this to be available or not. If you wish, you can define your own Custom Menu with anything you use often. Selecting something from the Custom Menu simply pastes that phrase into the command line.



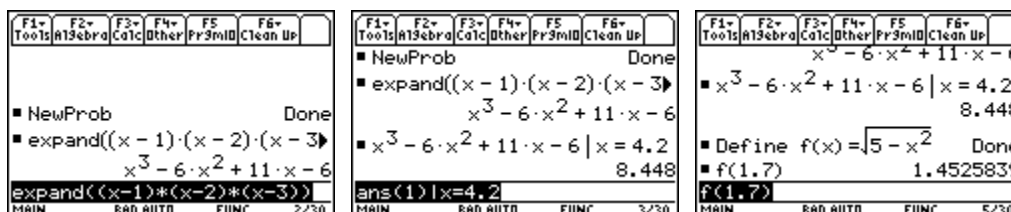
The MATH Menu (above the “5”) has many common mathematical commands. You can also type out the commands one character at a time, but this is slow. As with any menu, you can cursor down to highlight the command (as in the second figure) and press ENTER or you can press the number (or letter) in front of the command.



The CATALOG key brings up the catalog of all of the commands in the calculator. Press any key with a letter on it or above it (no need for the ALPHA first) while in the catalog to jump to commands beginning with that letter. Notice that when a command is selected (with the arrow), you get some on-screen help. The very bottom of the screen indicates the syntax required for that command. The syntax items will be separated by commas, and syntax items in square brackets [ ] are optional.



You can store a number in a variable name either with the F4 1:Define command or the STO→ key (which appears on the screen only as the arrow →). Then whenever you use that name, the value is immediately used. The F4 4:DelVar command is used to delete the definitions for these variable names. Note that F6 1:Clear a-z... and 2:NewProblem will not clear these longer variable names. **Suggestion:** Never store a number in the variables  $x$ ,  $y$ ,  $z$ , or  $t$  because we often use these letters for algebra variables. There is too great a chance you will forget to delete them before you want to use them as an undefined variable.



Alternatives to “storing a number in  $x$ ” are better. The “with” command is a vertical bar | key, and it allows a value to be substituted in for a variable temporarily without permanently storing that value in the variable name. When we define a function, then we can simply evaluate the function without storing anything permanently in the variable name.

### 3. Functions, Tables, and Graphs

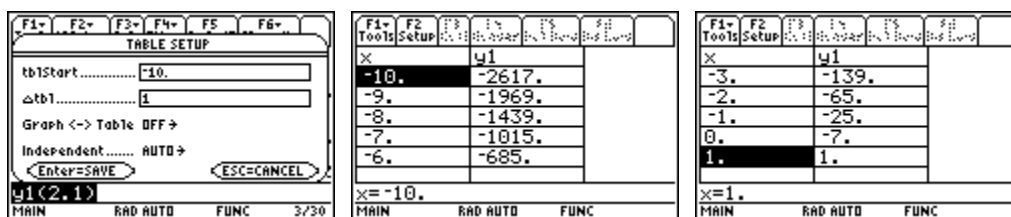


FUNCTION graphing

Y= Editor

Home

A formula entered into the Y= Editor (which you can get to via APPS 2:Y= Editor or via “green diamond” F1) is then available to you in the Home screen.



TblSet

Table

Table (scrolled down)

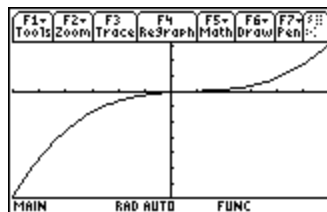
You can start a Table with any value, increment with any  $\Delta tbl$ , and then have the table automatically generated. Then you can scroll (up and down) to see evaluations of the function selected in the Y= Editor. Get in the habit of looking at a table *before* trying to set a viewing window for the function. For example, after looking at the table for this cubic polynomial, we decide on the following reasonable Window.

|              |              |             |              |             |             |            |
|--------------|--------------|-------------|--------------|-------------|-------------|------------|
| F1-<br>Tools | F2-<br>Setup | F3-<br>Zoom | F4-<br>Trace | F5-<br>Math | F6-<br>Draw | F7-<br>Pen |
| x            |              | y1          |              |             |             |            |
| 2.           |              | 11.         |              |             |             |            |
| 3.           |              | 35.         |              |             |             |            |
| 4.           |              | 85.         |              |             |             |            |
| 5.           |              | 173.        |              |             |             |            |
| 6.           |              | 311.        |              |             |             |            |
| x=6.         |              |             |              |             |             |            |
| MAIN         | RAD AUTO     | FUNC        |              |             |             |            |

Table (scrolled down)

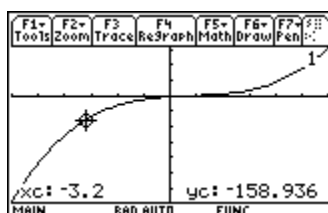
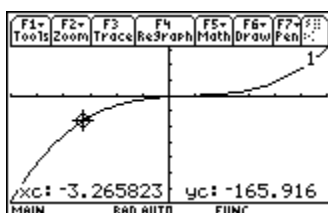
|              |             |              |                |             |             |            |
|--------------|-------------|--------------|----------------|-------------|-------------|------------|
| F1-<br>Tools | F2-<br>Zoom | F3-<br>Trace | F4-<br>ReGraph | F5-<br>Math | F6-<br>Draw | F7-<br>Pen |
| xmin=-6.     |             |              |                |             |             |            |
| xmax=6.      |             |              |                |             |             |            |
| xsc1=1.      |             |              |                |             |             |            |
| ymin=-685.   |             |              |                |             |             |            |
| ymax=311.    |             |              |                |             |             |            |
| ysc1=100.    |             |              |                |             |             |            |
| xres=2       |             |              |                |             |             |            |
| MAIN         |             | RAD AUTO     | FUNC           |             |             |            |

Window



Graph

Note that “xsc1” and “ysc1” give values to the marks on the axes. The setting “xres” equal to 2 causes points to be plotted in only every other column of the graph (thus only 79 columns out of the 159 on the TI-89). Since the points are connected, we don’t notice any “roughness” in the plot. A larger “xres” will plot more rapidly, but might miss important features of the plot. Further when you do F3 Trace, the cursor moves only to the plotted points based upon “xres”.



|                                 |             |              |                |             |             |            |
|---------------------------------|-------------|--------------|----------------|-------------|-------------|------------|
| F1-<br>Tools                    | F2-<br>Zoom | F3-<br>Trace | F4-<br>ReGraph | F5-<br>Math | F6-<br>Draw | F7-<br>Pen |
| 1:Value                         |             |              |                |             |             |            |
| 2:Zero                          |             |              |                |             |             |            |
| 3:Minimum                       |             |              |                |             |             |            |
| 4:Maximum                       |             |              |                |             |             |            |
| 5:Intersection                  |             |              |                |             |             |            |
| 6:Derivatives                   |             |              |                |             |             |            |
| 7:∫f(x)dx                       |             |              |                |             |             |            |
| 8:Inflection                    |             |              |                |             |             |            |
| TYPE OR USE ←+ (ENTER) OR (ESC) |             |              |                |             |             |            |

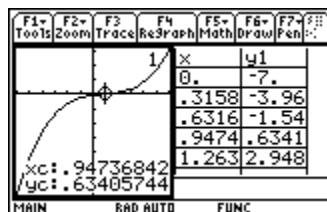
In the first figure, we Trace with the cursor to near  $x = -3.2$ . While tracing, we can also type  $-3.2$  to see the more exact value there. The F5 Math 1:Value command will also evaluate the function wherever we want on the interval from “xmin” to “xmax”.

|                             |               |               |
|-----------------------------|---------------|---------------|
| MODE                        |               |               |
| F1-<br>Pa3e 1               | F2-<br>Pa3e 2 | F3-<br>Pa3e 3 |
| Split Screen.....           | LEFT-RIGHT →  |               |
| Split 1 App.....            | Graph →       |               |
| Split 2 App.....            | Graph →       |               |
| Number of Graphs: 13        |               |               |
| Split: On/Off               |               |               |
| Exact/Approx: AUTO          |               |               |
| Base: DEC                   |               |               |
| Enter=SAVE                  |               | ESC=CANCEL    |
| USE ← AND → TO OPEN CHOICES |               |               |

MODE Page 2 Split Screen

|                  |             |              |                |             |             |            |
|------------------|-------------|--------------|----------------|-------------|-------------|------------|
| F1-<br>Tools     | F2-<br>Zoom | F3-<br>Trace | F4-<br>ReGraph | F5-<br>Math | F6-<br>Draw | F7-<br>Pen |
| TABLE SETUP      |             |              |                |             |             |            |
| tblStart.....    | 2.          |              |                |             |             |            |
| Δtbl.....        | 1.          |              |                |             |             |            |
| Graph ↔ Table    | 1:OFF       |              |                |             |             |            |
| Independent..... | 2:ON        |              |                |             |             |            |
| Enter=SAVE       |             | ESC=CANCEL   |                |             |             |            |
| MAIN             | RAD AUTO    | FUNC         |                |             |             |            |

Table Setup



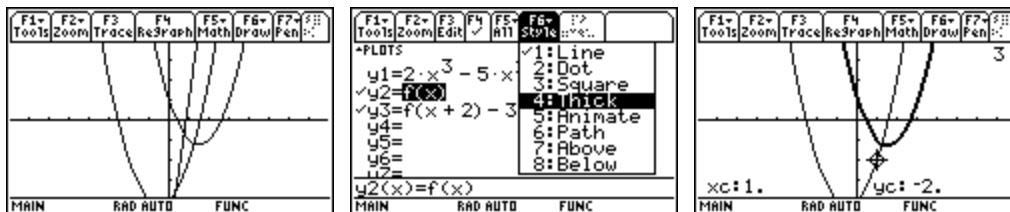
Graph/Table

With the split screen, you can have the Graph and the Table appearing on the same screen. The symbol above the APPS key is the toggle to move from one side of the screen to the other (and you must move to the Table side to have the table generated). Here we have the Table tied directly to the points actually plotted in the Graph via the Table Setup choice in the second figure above.

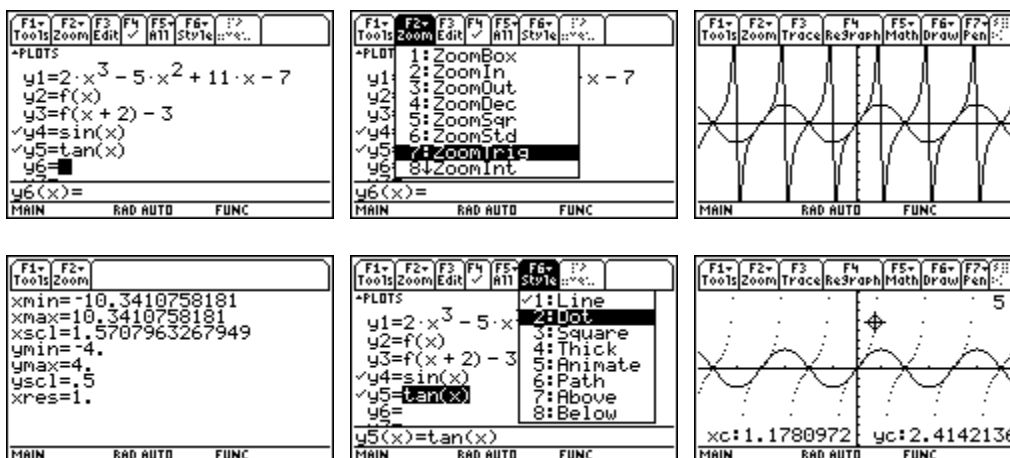
|  |                |             |              |               |                 |
|--|----------------|-------------|--------------|---------------|-----------------|
| F1-<br>Tools                           | F2-<br>At3ebra | F3-<br>Calc | F4-<br>Other | F5-<br>Pr3mID | F6-<br>Clean Up |
| NewProb Done                           |                |             |              |               |                 |
| Define f(x)=x <sup>2</sup> -3·x+1 Done |                |             |              |               |                 |
| Define f(x)=x <sup>2</sup> -3x+1       |                |             |              |               |                 |
| MAIN                                   | RAD AUTO       | FUNC        |              | 2/30          |                 |

|   |             |             |            |              |              |              |
|---|-------------|-------------|------------|--------------|--------------|--------------|
| F1-<br>Tools                                  | F2-<br>Zoom | F3-<br>Edit | F4-<br>All | F5-<br>Style | F6-<br>Style | F7-<br>Style |
| -PLOTS  |             |             |            |              |              |              |
| y1=2·x <sup>3</sup> -5·x <sup>2</sup> +11·x-7 |             |             |            |              |              |              |
| y2=f(x)                                       |             |             |            |              |              |              |
| y3=f(x+2)-3                                   |             |             |            |              |              |              |
| y4=   |             |             |            |              |              |              |
| y5=   |             |             |            |              |              |              |
| y6=   |             |             |            |              |              |              |
| y7=   |             |             |            |              |              |              |
| y4(x)=  |             |             |            |              |              |              |
| MAIN  | RAD AUTO    | FUNC        |            |              |              |              |

|              |             |             |            |              |              |              |
|--------------|-------------|-------------|------------|--------------|--------------|--------------|
| F1-<br>Tools | F2-<br>Zoom | F3-<br>Edit | F4-<br>All | F5-<br>Style | F6-<br>Style | F7-<br>Style |
| -PLOT        |             |             |            |              |              |              |
| 1:ZoomBox    |             |             |            |              |              |              |
| 2:ZoomIn     |             |             |            |              |              |              |
| 3:ZoomOut    |             |             |            |              |              |              |
| 4:ZoomDec    |             |             |            |              |              |              |
| 5:ZoomSqr    |             |             |            |              |              |              |
| 6:ZoomStd    |             |             |            |              |              |              |
| 7:ZoomTrig   |             |             |            |              |              |              |
| 8:ZoomInt    |             |             |            |              |              |              |
| y4(x)=       |             |             |            |              |              |              |
| MAIN         | RAD AUTO    | FUNC        |            |              |              |              |



Functions can be defined in the Home screen, but we can only graph a formula appearing in one of the function slots of the Y= Editor. (You can define a function with one of these function slot variable names in the Home screen.) When more than one function is selected, we may want to change the F6 Style to be able to tell them apart. In the Y= Editor, F4  $\checkmark$  will change whether a function slot is selected or not.

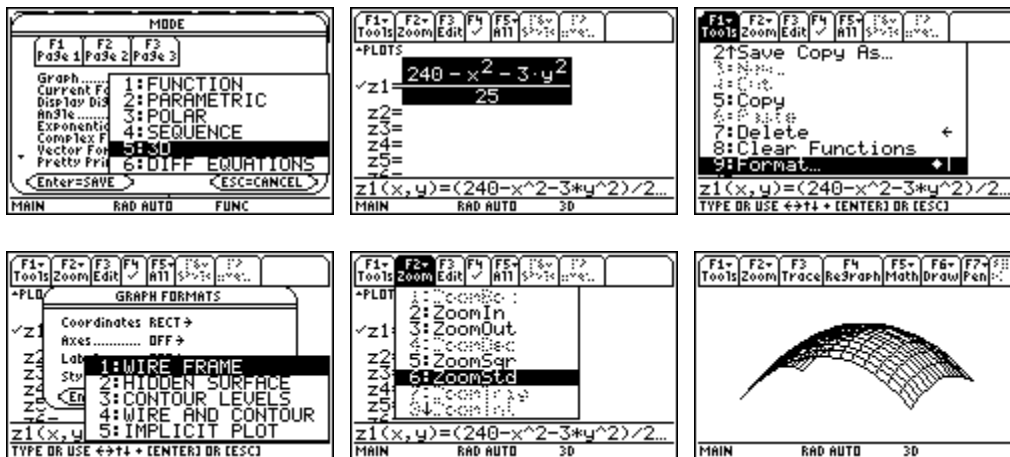


Notice that the default Line Style and “xres = 2” do not do such a great job plotting the tangent function. Generally we wish to avoid the false “near vertical” lines near vertical asymptotes. The Dot Style avoids this.



The “when” command gives us a way to do piecewise-defined functions, if there are not too many pieces. The Dot Style is also usually best for such piecewise-defined functions, which may not be continuous between the pieces.

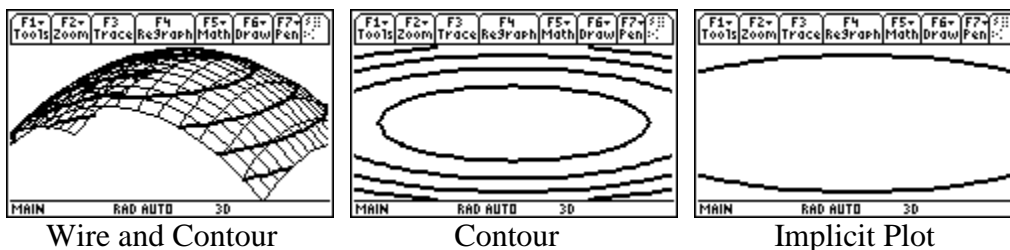
Certainly one of the most interesting features of the TI-89 is the ability to do 3D plotting. While somewhat limited compared to 3D computer plots, this is still an amazing feature for such a low-cost, low-resolution device. One example will be enough to introduce this feature.



Here we have given a function  $z = f(x, y)$  that shows nicely in the ZoomStd viewing “box”, namely

$$-10 \leq x \leq 10, \quad -10 \leq y \leq 10, \quad -10 \leq z \leq 10.$$

Always plot the function first in the WIRE FRAME Style because it is the fastest. Then when you are happy with the viewing “box” and the formula, you can explore the alternative styles.



#### 4. Entering Data, Performing a Regression

We show several ways to work with the data and plotting for a linear regression. Consider the following table of data.

|     |     |     |     |     |     |     |
|-----|-----|-----|-----|-----|-----|-----|
| $x$ | 1.2 | 1.7 | 2.0 | 2.6 | 2.8 | 3.1 |
| $y$ | 0.6 | 1.9 | 2.1 | 3.1 | 3.4 | 3.8 |

First we use the Data/Matrix Editor.



| F1-Tools           | F2-Plot Setup | F3-Cell | F4-Header | F5-Calc | F6-Util | F7-Stat |
|--------------------|---------------|---------|-----------|---------|---------|---------|
| DATA               |               |         |           |         |         |         |
|                    | c1            | c2      | c3        |         |         |         |
| 1                  | 1.2           | .6      |           |         |         |         |
| 2                  | 1.7           | 1.9     |           |         |         |         |
| 3                  | 2.            | 2.1     |           |         |         |         |
| 4                  | 2.6           | 3.1     |           |         |         |         |
| r4c2=3.1           |               |         |           |         |         |         |
| MAIN RAD AUTO FUNC |               |         |           |         |         |         |

| F1-Tools           | F2-Plot Setup | F3-Cell | F4-Header | F5-Calc | F6-Util | F7-Stat |
|--------------------|---------------|---------|-----------|---------|---------|---------|
| DATA               |               |         |           |         |         |         |
|                    | c1            | c2      | c3        |         |         |         |
| 4                  | 2.6           | 3.1     |           |         |         |         |
| 5                  | 2.8           | 3.4     |           |         |         |         |
| 6                  | 3.1           | 3.8     |           |         |         |         |
| 7                  |               |         |           |         |         |         |
| r7c2=              |               |         |           |         |         |         |
| MAIN RAD AUTO FUNC |               |         |           |         |         |         |

F2 Plot Setup

| F1-Tools           | F2-Plot Setup | F3-Cell  | F4-Header | F5-Calc | F6-Util | F7-Stat |
|--------------------|---------------|----------|-----------|---------|---------|---------|
| main\example       |               |          |           |         |         |         |
| F1-Define          | F2-Copy       | F3-Clear | F4-✓      |         |         |         |
| Plot 1:            |               |          |           |         |         |         |
| Plot 2:            |               |          |           |         |         |         |
| Plot 3:            |               |          |           |         |         |         |
| Plot 4:            |               |          |           |         |         |         |
| Plot 5:            |               |          |           |         |         |         |
| Plot 6:            |               |          |           |         |         |         |
| Plot 7:            |               |          |           |         |         |         |
| Plot 8:            |               |          |           |         |         |         |
| Plot 9:            |               |          |           |         |         |         |
| r7c2=              |               |          |           |         |         |         |
| MAIN RAD AUTO FUNC |               |          |           |         |         |         |

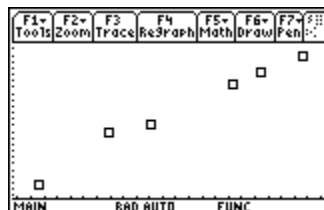
F1 Define

| F1-Tools                      | F2-Plot Setup | F3-Cell | F4-Header | F5-Calc | F6-Util | F7-Stat |
|-------------------------------|---------------|---------|-----------|---------|---------|---------|
| main\example Plot 1           |               |         |           |         |         |         |
| Plot Type: Scatter →          |               |         |           |         |         |         |
| Mark: Box →                   |               |         |           |         |         |         |
| X: c1                         |               |         |           |         |         |         |
| Y: c2                         |               |         |           |         |         |         |
| Use Free and Categories? NO → |               |         |           |         |         |         |
| Enter=SAVE ESC=CANCEL         |               |         |           |         |         |         |
| MAIN RAD AUTO FUNC            |               |         |           |         |         |         |

ENTER, then ESC Y=

| F1-Tools                         | F2-Plot Setup | F3-Cell | F4-Header | F5-Calc | F6-Util | F7-Stat |
|----------------------------------|---------------|---------|-----------|---------|---------|---------|
| -PLOT                            |               |         |           |         |         |         |
| 2                                | ZoomIn        |         |           |         |         |         |
| 3                                | ZoomOut       |         |           |         |         |         |
| 4                                | ZoomDec       |         |           |         |         |         |
| 5                                | ZoomSqr       |         |           |         |         |         |
| 6                                | ZoomStd       |         |           |         |         |         |
| 7                                | ZoomTrig      |         |           |         |         |         |
| 8                                | ZoomInt       |         |           |         |         |         |
| 9                                | ZoomData      |         |           |         |         |         |
| y1(x)=when(x<1, -x^2, x+1)       |               |         |           |         |         |         |
| TYPE OR USE ←→+ [ENTER] OR [ESC] |               |         |           |         |         |         |
| MAIN RAD AUTO FUNC               |               |         |           |         |         |         |

F2 9:ZoomData



It takes all of this to get the scatter plot of the data. Notice that performing ZoomData after the Plot 1 has been defined gives a nice viewing window for the plot (we are back in Function graphing).

| F1-Tools           | F2-Plot Setup | F3-Cell | F4-Header | F5-Calc | F6-Util | F7-Stat |
|--------------------|---------------|---------|-----------|---------|---------|---------|
| DATA               |               |         |           |         |         |         |
|                    | c1            | c2      | c3        |         |         |         |
| 4                  | 2.6           | 3.1     |           |         |         |         |
| 5                  | 2.8           | 3.4     |           |         |         |         |
| 6                  | 3.1           | 3.8     |           |         |         |         |
| 7                  |               |         |           |         |         |         |
| r7c2=              |               |         |           |         |         |         |
| MAIN RAD AUTO FUNC |               |         |           |         |         |         |

Return to current data

| F1-Tools               | F2-Plot Setup | F3-Cell | F4-Header | F5-Calc | F6-Util | F7-Stat |
|------------------------|---------------|---------|-----------|---------|---------|---------|
| main\example Calculate |               |         |           |         |         |         |
| Calculation Type..     |               |         |           |         |         |         |
| 1                      | OneVar        |         |           |         |         |         |
| 2                      | TwoVar        |         |           |         |         |         |
| 3                      | CubicReg      |         |           |         |         |         |
| 4                      | ExpReg        |         |           |         |         |         |
| 5                      | LnReg         |         |           |         |         |         |
| 6                      | LnReg         |         |           |         |         |         |
| 7                      | MedMed        |         |           |         |         |         |
| 8                      | PowerReg      |         |           |         |         |         |
| Enter=SAVE ESC=CANCEL  |               |         |           |         |         |         |
| MAIN RAD AUTO FUNC     |               |         |           |         |         |         |

F5 Calculate

| F1-Tools                      | F2-Plot Setup | F3-Cell | F4-Header | F5-Calc | F6-Util | F7-Stat |
|-------------------------------|---------------|---------|-----------|---------|---------|---------|
| main\example Calculate        |               |         |           |         |         |         |
| Calculation Type.. LinReg →   |               |         |           |         |         |         |
| X: c1                         |               |         |           |         |         |         |
| Y: c2                         |               |         |           |         |         |         |
| Store ResEQ to... y1(x) →     |               |         |           |         |         |         |
| Use Free and Categories? NO → |               |         |           |         |         |         |
| Enter=SAVE ESC=CANCEL         |               |         |           |         |         |         |
| MAIN RAD AUTO FUNC            |               |         |           |         |         |         |

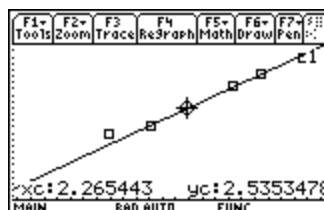
USE ← AND → TO OPEN CHOICES

| F1-Tools           | F2-Plot Setup | F3-Cell | F4-Header | F5-Calc | F6-Util | F7-Stat |
|--------------------|---------------|---------|-----------|---------|---------|---------|
| STAT VARS          |               |         |           |         |         |         |
| y=a+bx             |               |         |           |         |         |         |
| a =1.619898        |               |         |           |         |         |         |
| b =1.134439        |               |         |           |         |         |         |
| corr =.8906        |               |         |           |         |         |         |
| R2 =.981288        |               |         |           |         |         |         |
| Enter=OK           |               |         |           |         |         |         |
| MAIN RAD AUTO FUNC |               |         |           |         |         |         |

Current Stat Vars

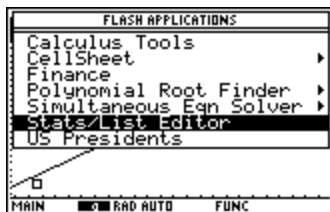
| F1-Tools                     | F2-Plot Setup | F3-Cell | F4-Header | F5-Calc | F6-Util | F7-Stat |
|------------------------------|---------------|---------|-----------|---------|---------|---------|
| -PLOTS 1                     |               |         |           |         |         |         |
| y1=1.6198979591837 * x + -1. |               |         |           |         |         |         |
| y2                           |               |         |           |         |         |         |
| y3                           |               |         |           |         |         |         |
| y4                           |               |         |           |         |         |         |
| y5                           |               |         |           |         |         |         |
| y6                           |               |         |           |         |         |         |
| y7                           |               |         |           |         |         |         |
| y1(x)=1.6198979591837*x+...  |               |         |           |         |         |         |
| MAIN RAD AUTO FUNC           |               |         |           |         |         |         |

Y= Editor

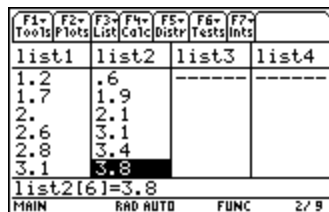
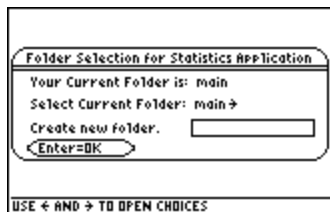


Graph and F3 Trace

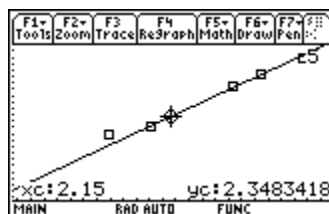
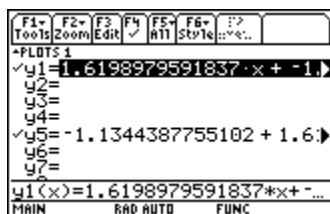
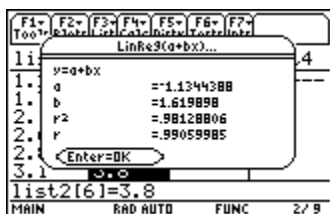
Above we see the steps to calculate the linear regression, store the formula in slot y1(x), and then look at the graph with both the scatter plot and the regression line. Most people found this statistical process a little cumbersome compared to the more advanced statistics on the TI-83. TI has also offered a free flash application called the Statistics List Editor with all of the power and ease of use of the TI-83 (and even additional statistical commands). Most new TI-89's come with this flash application loaded, and anyone can download it from the web site.



APPS 1:FlashApps



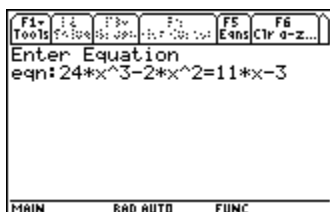
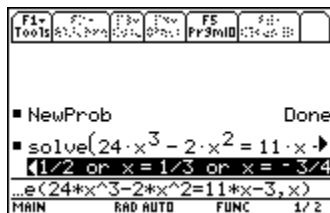
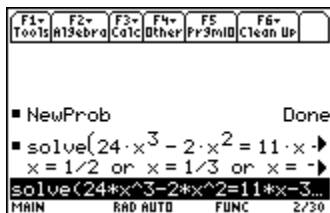
Type data in lists



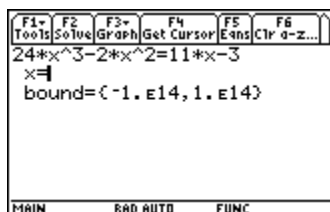
Statistics, including linear regression, can also be done in the CellSheet flash application, which gives a mini-spreadsheet for this family of calculators. The CellSheet costs extra for the TI-89 but comes loaded in a Voyage 200.

## 5. Solving Equations

We can solve some equations exactly with the symbolic command F2 1:solve( in the Home screen. We can also solve equations numerically in the Numeric Solver application. We can also graph both side of an equation, and seek an intersection point. We demonstrate an example of each method.



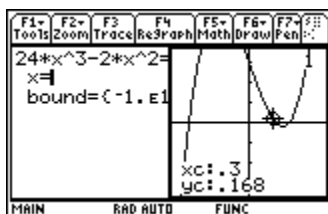
Enter Equation



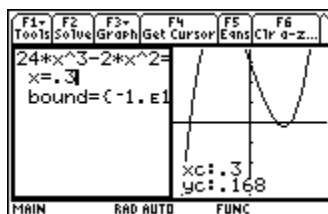
Ready to Solve



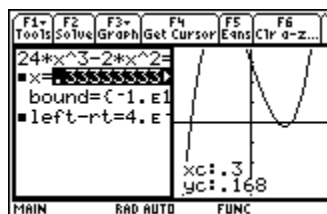
Graph "Left - Right"



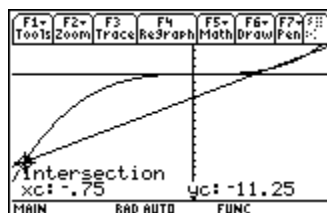
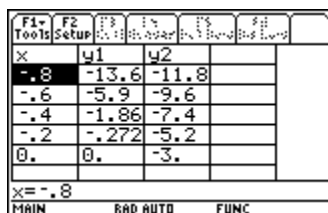
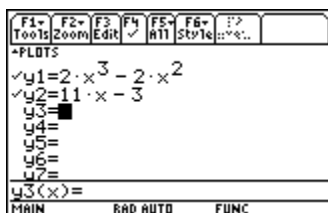
Trace for approximate



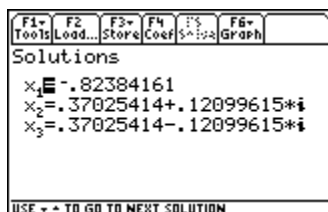
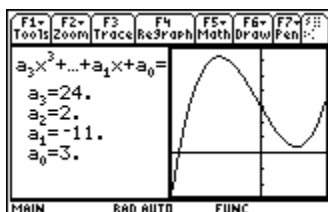
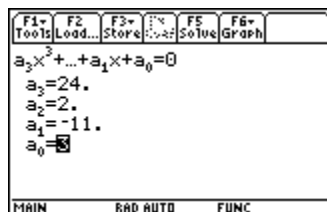
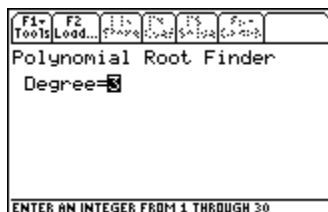
Seed solver, F2 Solve



Numeric Solution



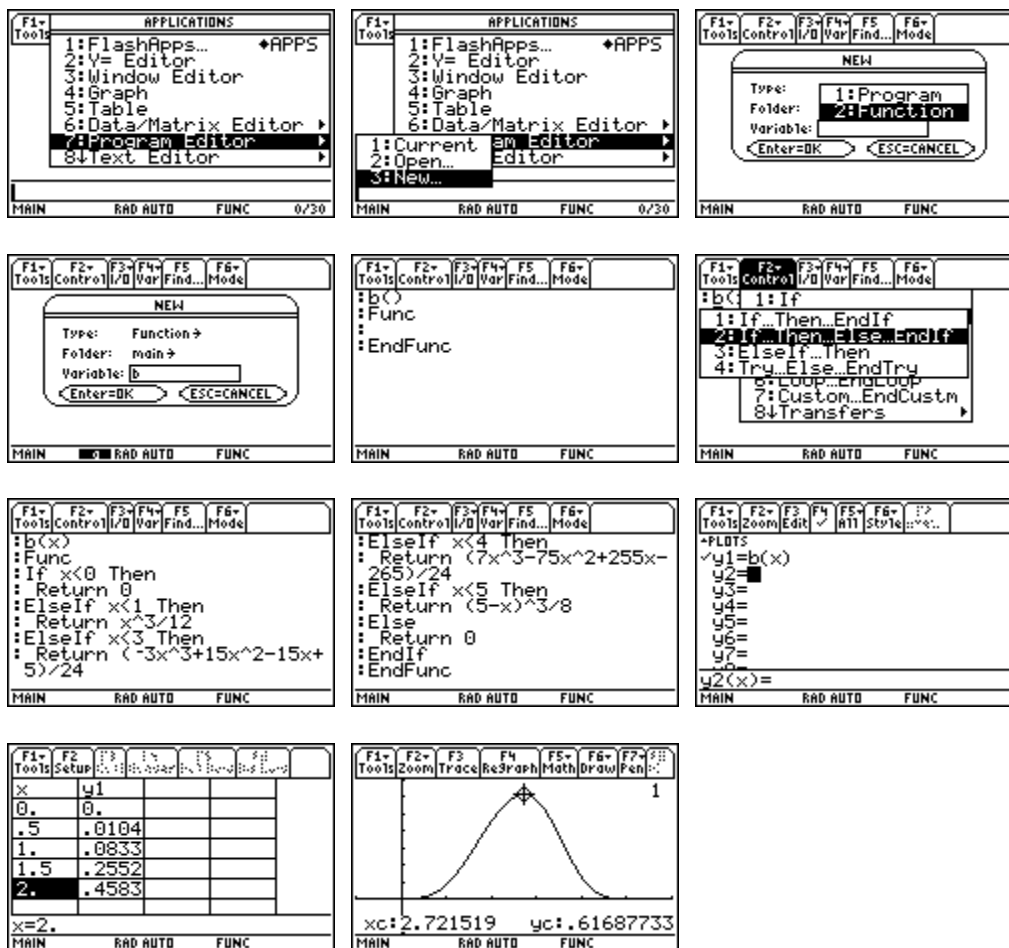
There is also a free flash application that finds numerical real and complex zeros of polynomials.



## 6. Programming

The early graphing calculators had relatively few features. Thus there was a need to write short programs to do many of the activities in pre-calculus and calculus. Now as I look back at the calculator programs that I wrote 10 or 15 years ago, I find that most of the things I tried to do are now easily provided to the user in some command or application. Still there is occasionally something we want to do repeatedly that is not yet provided. Here we simply look at an example of a function-type program that returns a value. This provides a more understandable way to implement a piecewise-defined function with many pieces. Consider the following function (a B-spline).

$$b(x) = \begin{cases} \frac{1}{12}x^3, & \text{if } 0 \leq x < 1 \\ \frac{1}{24}(-3x^3 + 15x^2 - 15x + 5), & \text{if } 1 \leq x < 3 \\ \frac{1}{24}(7x^3 - 75x^2 + 255x - 265), & \text{if } 3 \leq x < 4 \\ \frac{1}{8}(5-x)^3, & \text{if } 4 \leq x < 5 \\ 0, & \text{else} \end{cases}$$

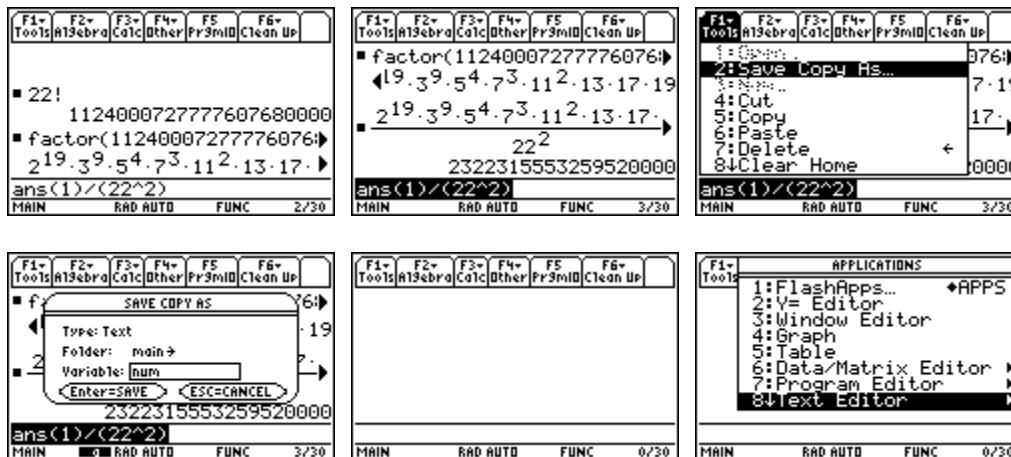


A function-type program returns a value (or an algebraic object). Thus it can be used in the Home screen, in the Y= Editor, and in other places just as you would use a built-in function. A program-type program will display its output on the I/O screen while it is running. Generally you cannot use the results outside of the program-type program.

## 7. Saving Your Work in a Text File

You may do a sequence of command lines in the Home screen that you would like to save for later use. Perhaps you have not finished, but you need to do something else with the calculator

now. Perhaps the sequence is appropriate to use again and again (somewhat like a program). We show here how to save the command lines represented in the history.



Give name to text

F1 8:ClearHome



Notice that the actual value was inserted wherever we used the ANS key or a continuation computation. This text file can be edited, perhaps to put “ans(1)” into these places. With the cursor within some line in the text, press F4 Execute to have that command line (preceded with the “C:”) executed back in the Home screen. Most of the time, we select under F3 View 1:Script view to split the screen vertically so that we can see both the text file and the Home screen result.

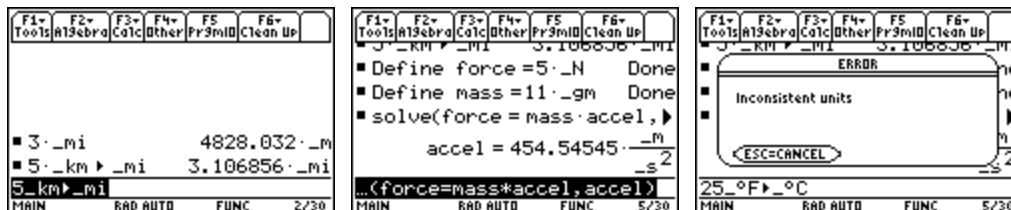
## 8. Units

Calculations for science and engineering always involve units. Mathematics instructors are often guilty of ignoring units (really they just assume they are correct). The calculator has several features that help you work with units and standard constants. First, there is a Page 3 Mode setting for the default unit system. The first two choices are the metric system (SI for System International) and the English system. Above the “3” key is the Units command to bring up the units menu. They have tried to give you units in the order most often needed (not alphabetical), so explore what is given.

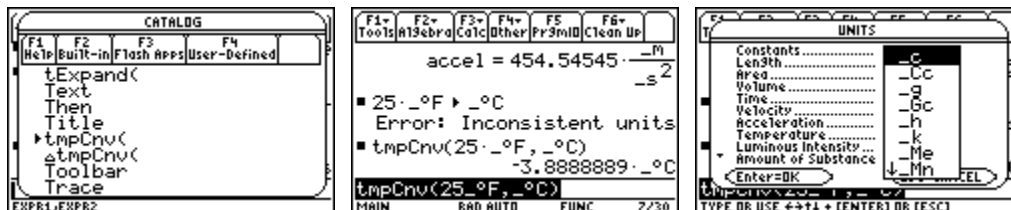


You type a number and then attach the unit after it. It is easier to get the unit designation from the menu. You can also type the symbols, but notice that all unit designations begin with an “underbar”. In the third figure above we have attached miles to 3. The calculator automatically converts the result to the mode-specified unit system, here to meters.

You can also convert from one unit to another in the same category. Simply type the desired number, attach the original unit, press the “bold arrow” above the MODE key, and attach the new unit desired.



If you assign units to objects in an algebraic expression, as in the second figure above, the “solved” variable will be given the appropriate units (in the mode-selected system). For some strange reason, temperature conversion does not work in the same way. Look in the CATALOG for the command tmpCnv().



The first line of the units menu gives many common constants from science and engineering. For example “\_Gc” is Newton’s universal gravitation constant which in the SI system equals  $6.67259E-11$  in  $m^3/(kg \cdot s^2)$ .

## 9. Connecting to a Computer, Other Applications

All TI graphing calculators come with a short cable to connect one calculator to another calculator. A GraphLink cable is for connecting the calculator to a computer. Older GraphLink cables (grey and black) plug into the COM port of a PC or the modem port of a Macintosh. The newer GraphLink cables (silver) use a USB connection (for both PC’s and Macintoshes). You will need such a cable to upgrade the OS or to download new applications. You can also save your work (text files, programs, functions) on the computer. All of the figures in this document have been obtained using the GraphLink connection. The Voyage 200 comes with the GraphLink cable and software. TI-89 users may want to purchase a GraphLink cable (about \$20). The latest computer software for connection with the GraphLink cable can always be downloaded for free from the TI web site (<http://education.ti.com>). The Arts and Sciences Computing Labs on the third floor of Rood Hall have GraphLink cables for both PC’s and

Macintoshes and the required software on the server. On the new engineering campus, the CEAS computer lab has the required software on the server and you may check out a USB GraphLink cable from the desk.

We have already mentioned two flash applications that are free, the Statistics List Editor and the Polynomial Root Finder. Other free flash applications available now for the TI-89 are Calculus Tools, Finance, Simultaneous Equation Solver, Symbolic Math Guide, Study Cards, and US Presidents. Cost flash applications include CellSheet (mini spread sheet \$15), Equation Writer (\$15), EE200 (circuit analysis \$20), ME\*Pro (mechanical engineering \$50), EE\*Pro (electrical engineering \$50), The Geometer's Sketchpad (\$30), and Cabri Geometry (\$30). Some of these cost applications come preloaded in the Voyage 200. Recently they have added a free Organizer (address/phone and calendar/appointment book) for this family of calculators.