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This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference with radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, you can try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/television technician for help.

Caution: Any changes or modifications to this equipment not expressly approved by Texas Instruments may void your authority to operate the equipment.
This manual describes how to use the TI-80 Graphing Calculator. Getting Started gives a quick overview of its features. The first chapter gives general instructions on operating the TI-80. Other chapters describe its interactive features. The applications in Chapter 11 show how to use these features together.

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Using this Guidebook Effectively

The structure of the TI-80 guidebook and the design of its pages can help you find the information you need quickly. Consistent presentation techniques are used throughout to make the guidebook easy to use.

**Structure of the Guidebook**

The guidebook is designed to teach you how to use the calculator.

- Getting Started is a fast-paced, keystroke-by-keystroke introduction.
- Chapter 1 describes general operation and lays the foundation for Chapters 2 through 10, which describe specific functional areas of the TI-80. Most chapters begin with a brief Getting Started introduction.
- Chapter 11 contains application examples that incorporate features from different functional areas of the calculator. These examples can help you see how different functional areas work together to accomplish meaningful tasks.
- Chapter 12 describes memory management.

**Page-Design Conventions**

When possible, units of information are presented on a single page or on two facing pages. Several page-design elements help you find information quickly.

- **Page headings**—The descriptive heading at the top of the page or two-page unit identifies the subject of the unit.
- **General text**—Just below the page heading, a short section of bold text provides general information about the subject covered in the unit.
- **Left-column subheadings**—Each subheading identifies a specific topic or task related to the page or unit subject.
• **Specific text**—The text to the right of a subheading presents detailed information about that specific topic or task. The information may be presented as paragraphs, numbered procedures, bulleted lists, or illustrations.

• **Page “footers”**—The bottom of each page shows the chapter name, chapter number, and page number.

Several conventions are used to present information concisely and in an easily referenced format.

• **Numbered procedures**—A procedure is a sequence of steps that performs a task. In this guidebook, each step is numbered in the order in which it is performed. No other text in the guidebook is numbered; therefore, when you see numbered text, you know you should perform the steps sequentially.

• **Lists with bullets**—If several items have equal importance, or if you may choose one of several alternative actions, this guidebook precedes each item with a “bullet” (*) to highlight it—like this list.

• **Tables and charts**—Sets of related information are presented in tables or charts for quick reference.

• **Keystroke examples**—The Getting Started examples provide keystroke-by-keystroke instructions, as do the numerous short examples and several detailed examples that are identified with a \[\].
Reference Aids

Several techniques have been used to help you look up specific information when you need it. These include:

- A chapter table of contents on the first page of each chapter, as well as the full table of contents at the front of the guidebook.

- A glossary at the end of this section, defining important terms used throughout the guidebook.

- An alphabetical table of functions and instructions in Appendix A, showing their correct formats, how to access them, and page references for more information.

- Information about system variables in Appendix A.

- A table of error messages in Appendix B, showing the messages and their meanings and giving problem-handling information.

- An alphabetical index at the back of the guidebook, listing tasks and topics you may need to look up.
# Glossary

This glossary provides definitions for important terms that are used throughout this guidebook.

<table>
<thead>
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<th>Term</th>
<th>Definition</th>
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<tr>
<td>Argument</td>
<td>An argument is an input upon which the value of a function depends.</td>
</tr>
<tr>
<td>Command</td>
<td>A command is any entry submitted to the calculator using [ENTER]. There are two types of TI-80 commands: instructions and expressions.</td>
</tr>
<tr>
<td>Expression</td>
<td>An expression is a complete sequence of numbers, variables, functions, and their arguments that can be evaluated to a single answer. An expression returns the evaluated result to ANS.</td>
</tr>
<tr>
<td>Function</td>
<td>A function, which may have arguments, returns a value and can be used in an expression. A function is also the expression entered in the Y= editor used in graphing.</td>
</tr>
<tr>
<td>Home Screen</td>
<td>The Home screen is the primary screen of the TI-80, where expressions can be entered and evaluated and instructions can be entered and executed.</td>
</tr>
<tr>
<td>Instruction</td>
<td>An instruction, which may have arguments, initiates an action. Instructions are not valid in expressions. An instruction does not return a value to ANS.</td>
</tr>
<tr>
<td>List</td>
<td>A list is a set of values that the TI-80 can use for activities such as evaluating a function at multiple values and entering statistical data.</td>
</tr>
<tr>
<td>Menu Items</td>
<td>Menu items are shown on full-screen menus.</td>
</tr>
</tbody>
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A pixel (picture element) is a square dot on the TI-80 display. The TI-80 display is 64 pixels wide and 48 pixels high.

On the TI-80, real numbers are individual decimal or fraction values.

A value is a single decimal or fraction number or a list of decimals or fractions.

A variable is the name given to a location in memory in which a value, an expression, a list, or another named item is stored.
Getting Started: Do This First!

Getting Started contains two keystroke-by-keystroke examples—an interest rate problem and a volume problem—which introduce you to some principal operating and graphing features of the TI-80. You will learn to use the TI-80 more quickly by completing both of these examples first.

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TI-80 Keyboard

The keys on the TI-80 are grouped by color and physical layout to allow easy location of the key you need. The keys are divided into zones: graphing keys, editing keys, advanced function keys, and scientific calculator keys.

The Zones of the Keyboard

Graphing Keys
These keys are most frequently used to access the interactive graphing features of the TI-80.

Editing Keys
These keys are most frequently used for editing expressions and values.

Advanced Function Keys
These keys are most frequently used to access the advanced functions of the TI-80.

Scientific Calculator Keys
These keys are most frequently used to access the capabilities of a standard scientific calculator.
First Steps

Before beginning the two sample problems, follow the steps on this page to reset the TI-80 to its factory settings. (Resetting the TI-80 erases all previously entered data.) This ensures that following the keystrokes in this section produces the same actions.

1. Press \( \text{ON} \) to turn the calculator on.
   
   If the screen is very dark or blank, adjust the display contrast. Press and release \( \text{2nd} \), and then press and hold \( \geq \) (to make the display lighter) or press and hold \( \leq \) (to make the display darker). You can press \( \text{CLEAR} \) to clear the display.

2. Press and release \( \text{2nd} \), and then press \( \mu \). (Pressing \( \text{2nd} \) gives you access to the \( \text{2nd} \) operations, which are printed at the upper left of the keys. \( \text{MEM} \) is the \( \text{2nd} \) operation of the \( \mu \) key.)
   
   The MEMORY menu is displayed.

3. Press 3 to select \( \text{RESET...} \) from the MEMORY menu.
   
   The MEMORY RESET menu is displayed.

4. Press 2 to select \( \text{RESET} \) from the MEMORY RESET menu. The calculator is reset, and the MEM CLEARED message is displayed.

5. Press \( \text{ON} \) to turn the calculator on again.

6. Press \( \text{2nd} \) again, and then press \( \mu \). (Pressing \( \text{2nd} \) gives you access to the \( \text{2nd} \) operations, which are printed at the upper left of the keys. \( \text{MEM} \) is the \( \text{2nd} \) operation of the \( \mu \) key.)
   
   The MEMORY menu is displayed.

7. Press 3 to select \( \text{RESET...} \) from the MEMORY menu.
   
   The MEMORY RESET menu is displayed.

8. Press 1 to select \( \text{MEMORY} \) from the MEMORY RESET menu. The MEMORY menu is displayed.

9. Press 3 to select \( \text{MEM CLEARED} \) from the MEMORY menu.
To leave the keyboard uncluttered, the TI-80 uses full-screen menus to display many additional operations. The use of specific menus is described in the appropriate chapters.

Displaying a Menu

When you press a key that displays a menu, such as \texttt{MATH}, that menu screen temporarily replaces the screen where you are working.

After you make a selection from a menu, you usually are returned to the screen where you were.

Moving from One Menu to Another

A menu key may display more than one menu name. The names appear on the top line. The name of current menu is highlighted, and the items in that menu are displayed. Use \texttt{\downarrow} or \texttt{\uparrow} to display a different menu.

Selecting an Item from a Menu

The number of the current item is highlighted. If there are more than seven items on the menu, a \texttt{\downarrow} appears on the last line in place of the : (colon).

To select from a menu, you can either:

\begin{itemize}
  \item Use \texttt{\downarrow} and \texttt{\uparrow} to move the cursor to the item, and then press \texttt{ENTER}.
  \item Press the number of the item.
\end{itemize}

Note: The tenth item in a menu is number 0. If there are more than 10 items, they are numbered A, B, C, etc. To select one of these items, press \texttt{ALPHA} and then the letter.

Leaving without Making a Selection

To leave a menu without making a selection:

\begin{itemize}
  \item Press \texttt{\downarrow} \texttt{QUIT} to return to the Home screen.
  \item Press \texttt{CLEAR} to return to the screen where you were.
  \item Press the key for another screen or menu.
\end{itemize}
The TI-80 displays up to 8 16-characters lines so that you see an expression and its solution together. You can store values to variables, enter multiple instructions on one line, and recall previous entries.

Using trial and error, determine when an amount invested at 6% annual compounded interest will double in value.

1. For the first guess, compute the amount available at the end of 10 years. Enter the expression just as you would write it. (Use 1000 for the amount.)

   Press \( 1000 \times 1.06^10 \).

2. Press [ENTER] to evaluate the expression.

   The answer is shown on the right side of the display. The cursor is positioned on the next line, ready for you to enter the next expression.

3. The next guess should be greater than 10 years. Make the next guess 12 years. To calculate the amount after 12 years, press \( 1000 \times 1.06^{12} \), followed by [ENTER].
Getting Started

To save keystrokes, you can use the Last Entry feature to recall the last expression entered and then edit it for a new calculation. In addition, the next expression can be continued from the previous result.

1. The next guess should be less than, but close to, 12 years. Compute the amount available at the end of 11.9 years, using the Last Entry feature. Press $\boxed{\text{2}}$, followed by $\boxed{\llbracket \text{ENTRY} \rrbracket}$ (the second function of $\boxed{\text{ENTRY}}$).

The last calculated expression is shown on the next line of the display. The cursor is positioned at the end of the expression.

2. You can edit the expression. Press $\boxed{\text{6}}$ to move the cursor over the 2. Then type 1.9 to change 12 to 11.9. Press $\boxed{\text{ENTRY}}$ to evaluate the expression.

Note: This process can be continued to obtain a solution with the desired accuracy.

3. You can continue a calculation using the result of the last calculation. For example, if the final amount determined above is to be divided among seven people, how much would each person get?

To divide the last calculation by seven, press $\boxed{\text{7}}$, followed by $\boxed{\text{ENTRY}}$.

As soon as you press $\boxed{\text{7}}$, $\boxed{\text{ANS/7}}$ is displayed at the beginning of the new expression. $\boxed{\text{ANS}}$ is a variable that contains the last calculated result. In this case, $\boxed{\text{ANS}}$ contains 2000.505716.
Defining a Function: Box with Lid

Take an 8½”-x-11” sheet of paper and cut X by X squares from two corners and X by (X+B) rectangles from the other two corners. Now fold the paper into a box with lid. What X would give the maximum volume V of a box made in this way? Use tables and graphs to determine the solution.

Begin by defining a function that describes the volume of the box.

From the diagram:

\[ 2X + A = W \]
\[ 2X + 2B = L \]
\[ V = A B X \]

Substituting:
\[ V = (W - 2X) (L / 2 - X) X \]

If necessary, press \( \text{MODE} \) \( \text{ENTER} \) to change the MODE to FLOAT. Then press \( \text{2nd} \) \( \text{QUIT} \) \( \text{CLEAR} \) to return to the Home screen and clear it.

1. Press \( 8.5 \) \( \text{STO} \) \( \text{ALPHA} \) \( \text{W} \) \( \text{ENTER} \) to store the width of the paper.

Press \( 11 \) \( \text{STO} \) \( \text{ALPHA} \) \( \text{L} \) \( \text{ENTER} \) to store the length of the paper.

2. You define functions for tables and graphs on the \( \text{Y=} \) edit screen.

Press \( \text{Y=} \) to access this screen.

3. Enter the function for volume as \( Y_1 \). Press \( \text{APP} \) \( \text{ALPHA} \) \( \text{W} \) \( \text{2} \) \( \text{X} \) \( \text{STO} \) \( \text{ALPHA} \) \( \text{L} \) \( \text{2} \) \( \text{X} \) \( \text{X} \) \( \text{STO} \) \( \text{ALPHA} \) \( \text{X} \) \( \text{ENTER} \)

\( Y_1 \) lets you enter \( X \) quickly without pressing \( \text{ALPHA} \). (\( \text{Y=} \) lets you enter \( X \) quickly without pressing \( \text{STO} \).)

The \( \text{=} \) sign is highlighted to show that \( Y_1 \) is selected.
Defining a Table of Values

The table feature of the TI-80 provides numeric information about a function. Use a table of values from the previously defined function to estimate an answer to the problem.

1. Press `2nd [TBLSET]` (above [WINDOW]) to display the **TABLE SETUP** screen.
2. Press [ENTER] to accept TBLMIN=0.
3. Press `.5 [ENTER]` to define the table increment ΔTBL=.5.
4. Press `2nd [TABLE]` (above [GRAPH]) to display the table.
   
   Note that the maximum value is around 1.5, between 1 and 2.

5. Press and hold `†` to scroll the table until the sign change appears. Note that the maximum length of X for this problem occurs where the sign of Y1 (volume) becomes negative.

6. Press `2nd [TBLSET]`. Note that TBLMIN has changed to reflect the first line of the table you last displayed.
Zooming In on the Table

You can adjust the way a table is displayed to get more detailed information about any defined function. By varying the value of \( \Delta TBL \), you can “zoom in” on the table.

1. Adjust the table setup to get a more accurate estimate of the maximum size of the cutout. Press 1 [ENTER] to set TBLMIN. Press .1 to set \( \Delta Tbl \).

2. Press 2nd [TABLE].

3. Use \( \leftarrow \) and \( \rightarrow \) to scroll the table. Note that the maximum value displayed is 33.072, which occurs at \( X=1.6 \). The maximum occurs at 1.5<\( X <1.7 \).
4. Press [2nd] [TBLSET], Press 1.5 [ENTER] to set TBLMIN. Press .01 [ENTER] to set △TBL.

5. Press [2nd] [TABLE] and use † and ‡ to scroll the table. Two “equal” maximum values are shown, 33.074 at \(X=1.58\) and \(X=1.59\).

6. Press † or ‡ to move the cursor to 1.58. Press † to move the cursor into the \(Y_1\) column. The bottom line of the display shows the value of \(Y_1\) at 1.58 in full precision, 33.073824.

7. Press † to display the “other” maximum. The value of \(Y_1\) at 1.59 in full precision is 33.073908. This would be the maximum volume of the box if you could cut your piece of paper at .01-inch increments.
Changing the Viewing Window

The viewing window defines the portion of the coordinate plane that appears in the display. The values of the Window variables determine the size of the viewing window. You can view and change these values.

1. Press `WINDOW` to display the Window variables edit screen. You can view and edit the values of the Window variables here.

![Window Variables](image)

The standard Window variables define the viewing window as shown. `XMIN`, `XMAX`, `YMIN`, and `YMAX` define the boundaries of the display. `XSCL` and `YSCL` define the distance between tick marks on the X and Y axes.

2. Press `0 ENTER` to define `XMIN`.

3. You can enter expressions to define values in the window editor. Press `8.5 ÷ 2`.

4. Press `ENTER`. The expression is evaluated, and `4.25` is stored in `XMAX`. Press `ENTER` to accept `XSCL` as `1`.

5. Press `0 ENTER 40 ENTER 10 ENTER` to define the Y Window variables.

![Window Variables](image)
Displaying and Tracing the Graph

Now that you have defined the function to be graphed and the window in which to graph it, you can display and explore the graph. You can trace along a function with TRACE.

1. Press [GRAPH] to graph the selected function in the viewing window.
   
   The graph of \( Y_1 = (W - 2X)(L/2 - X)X \) is shown in the display.

2. Press \( \downarrow \) once to display the free-moving cursor just to the right of the center of the screen. The bottom line of the display shows the X- and Y-coordinate values for the position of the graph cursor.

3. Use \( \uparrow, \downarrow, \left\{, \right\}, \) and \( \dag \) to position the free-moving cursor at the apparent maximum of the function.
   
   As you move the cursor, X- and Y-coordinate values are updated continually to reflect the cursor position.

4. Press [TRACE]. The Trace cursor appears on the \( Y_1 \) function. \( 1 \) in the upper right corner of the display shows that the cursor is on \( Y_1 \). As you press \( \uparrow \) and \( \downarrow \), you trace along \( Y_1 \), one \( X \) dot at a time, evaluating \( Y_1 \) at each \( X \).

5. Press \( \uparrow \) and \( \downarrow \) until you are on the maximum Y value. This is the maximum of \( Y_1(X) \) for the X pixels. (There may be a maximum value “in between” pixels.)
Zooming In on the Graph

You can magnify the viewing window around a specific location using the Zoom instructions to help identify maximums, minimums, roots, and intersections of functions.

1. Press \( \text{ZOOM} \) to display the \( \text{ZOOM} \) menu.
   - This menu is typical of TI-80 menus. To select an item, you may either press the number to the left of the item, or you may press \( \uparrow \) until the item number is highlighted and then press \( \text{ENTER} \).

2. To ZOOM IN, press 2. The graph is displayed again. The cursor has changed to indicate that you are using a Zoom instruction.

3. Use \( \uparrow, \downarrow, \leftarrow, \rightarrow \) to position the cursor near the maximum value on the function, and press \( \text{ENTER} \).
   - The new viewing window is displayed. It has been adjusted in both the \( X \) and \( Y \) directions by factors of 4, the values for Zoom factors.

4. Press \( \text{WINDOW} \) to display the new window variable values.
Other TI-80 Features

Getting Started has introduced you to basic calculator operation and the table and function graphing features of the TI-80. The remainder of this Guidebook describes these features in more detail and also covers other capabilities of the TI-80.

Fractions
You can enter fractions directly from the keyboard and perform calculations with fractions. You can convert between fractions and their decimal equivalents. In MANSIMP mode, you can simplify fractions step-by-step. The TI-80 tells you when a fraction can be simplified and shows the common factor after simplification (Chapter 3).

Graphing
You can store, graph, and analyze up to four functions (Chapter 4) and up to three parametric functions (Chapter 5). You can use Draw operations to annotate graphs (Chapter 7).

Tables
You can create function evaluation tables to analyze multiple functions simultaneously (Chapter 6).

Lists
You can enter and save up to six lists for use in statistical analysis. You also can use lists to evaluate expressions at multiple values simultaneously (Chapter 8).

Statistics
You can perform one-variable and two-variable list-based statistical analysis, including regression analysis, and plot the data as histograms, points, x-y lines, or box-and-whisker plots. You can define and save three statistical plot definitions (Chapter 9).

Programming
You can enter and save programs that include extensive control and input/output instructions (Chapter 10)
# Chapter 1: Operating the TI-80

This chapter describes the TI-80 and provides general information about its operation.

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<th>Page</th>
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<td>1-22</td>
</tr>
</tbody>
</table>
Turning the TI-80 On and Off

To turn the TI-80 on, press the \textbf{ON} key. To turn it off, press and release \textbf{2nd}, and then press \textbf{OFF}. After about five minutes without any activity, the APD\textsuperscript{TM} (Automatic Power Down\textsuperscript{TM}) feature turns the TI-80 off automatically.

<table>
<thead>
<tr>
<th>Turning the Calculator On</th>
<th>Press \textbf{ON} to turn the TI-80 on.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>\textbullet{} If you pressed \textbf{2nd} \textbf{OFF} to turn the calculator off, the display shows the Home screen as it was when you last used it, and errors are cleared.</td>
</tr>
<tr>
<td></td>
<td>\textbullet{} If APD turned the calculator off, the display returns to the same screen or editor in which you left it. See &quot;APD (Automatic Power Down)&quot; below.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Turning the Calculator Off</th>
<th>Press and release \textbf{2nd}, and then press \textbf{OFF} to turn the TI-80 off.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>\textbullet{} Any error condition is cleared.</td>
</tr>
<tr>
<td></td>
<td>\textbullet{} All settings and memory contents are retained by the Constant Memory\textsuperscript{TM} feature.</td>
</tr>
</tbody>
</table>

**APD\textsuperscript{TM} (Automatic Power Down\textsuperscript{TM})**

To prolong the life of the batteries, APD turns the TI-80 off automatically after several minutes without any activity. When you press \textbf{ON}, the calculator shows the same screen or editor in which you left it.

- If an error message was displayed when APD turned the TI-80 off, the error is cleared, and the display returns to a blank line on the Home screen.
- If a menu was displayed, the display returns to the screen or editor from which you called the menu.

All settings and memory contents are retained by the Constant Memory feature.

**Note:** APD does not occur if a calculation or program is in progress, unless the program is paused.

**Batteries**

The TI-80 uses two CR2032 lithium batteries. To replace the batteries without losing any information stored in memory, follow the directions in Appendix B.
Setting the Display Contrast

The brightness and contrast of the display depend on room lighting, battery freshness, viewing angle, and the adjustment of the display contrast. The contrast setting is retained in memory when the TI-80 is turned off.

**Adjusting the Display Contrast**

You can adjust the display contrast to suit your viewing angle and lighting conditions. As you adjust the contrast setting, the display becomes lighter or darker. A highlighted number in the upper right corner changes to indicate the current contrast setting; 0 is the lightest, and 9 is the darkest.

To adjust the display contrast:

1. Press and release the 2 key.
2. Use one of two keys:
   - To increase the contrast (darken the screen), press and hold 7.
   - To decrease the contrast (lighten the screen), press and hold 8.

**Note:** The display may become completely blank if you adjust the contrast setting too low. If this happens, press and release 2nd, and then press and hold 2 until the display reappears.

**When to Replace Batteries**

As you use the TI-80, the battery voltage will gradually drop, and the display will dim. You can adjust the contrast to darken the display when this happens. If the display is dim and adjusting the contrast to level 9 does not make it dark enough, you should replace the batteries. Refer to Appendix B for instructions on how to change the batteries.

**Note:** After you change batteries, the display contrast may appear very dark. Press and release 2nd, and then press and hold 2 to lighten the display.
The Display

The TI-80 displays both text and graphs. Graphs are described in Chapters 4 and 5.

**Home Screen**

The primary screen of the TI-80 is the Home screen. You enter instructions to be executed, expressions to be evaluated, and see the results on the Home screen.

**Displaying Entries and Answers**

When text is displayed, the TI-80 screen can show a maximum of eight lines with 16 characters each.

- If all lines of the display are filled, text “scrolls” off the top of the display.
- If an expression on the Home screen, the Y= editor (Chapter 4), or the program editor (Chapter 10) is longer than one line, it wraps to the beginning of the next line.
- On numeric editors such as the Window screen (Chapter 4), an expression scrolls to the left and right.

When an entry is executed on the Home screen, the answer is displayed on the right side of the next line.

```
252
625
```

--- Entry
--- Answer

The mode settings (pages 1-9 through 1-11) control the way the calculator interprets expressions and displays answers.

If an answer is too long to display in its entirety, you can press [1] and [2] to scroll the answer so that you can view all of it. In the second example below, the open brace without a corresponding close brace indicates that the list is too long to be displayed in its entirety.

```
L1
L2
L3
```

--- Entry
--- Answer
--- Answer
--- Answer (scrolled)

**Returning to the Home Screen**

To return to the Home screen from any other screen, press [2nd] [quit].
Display Cursors

In most cases, the appearance of the cursor indicates what will happen when you press the next key.

<table>
<thead>
<tr>
<th>Cursor</th>
<th>Appearance</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entry</td>
<td>Blinking ■</td>
<td>The next keystroke is entered at the cursor; it types over any character.</td>
</tr>
<tr>
<td>INS (insert)</td>
<td>Blinking _</td>
<td>The next keystroke is inserted at the cursor.</td>
</tr>
<tr>
<td>2nd</td>
<td>Blinking 1</td>
<td>The next keystroke is a 2nd operation.</td>
</tr>
<tr>
<td>ALPHA</td>
<td>Blinking A</td>
<td>The next keystroke is an alphabetic character.</td>
</tr>
<tr>
<td>memory “full”</td>
<td>Checkerboard rectangle</td>
<td>You have entered the maximum number of characters in a name, or memory is full.</td>
</tr>
</tbody>
</table>

Graphs and the screens for viewing and editing tables and lists have different cursors, which are described in the appropriate chapters.

Busy Indicator

When the TI-80 is calculating or graphing, a vertical line shows in the upper right of the display as a busy indicator. During a pause in a program, the busy indicator is a dotted line.
Entering Expressions and Instructions

Expressions
An expression is a complete sequence of numbers, variables, functions, and their arguments that evaluate to a single answer. For example, \( \pi \times 2 \) is an expression. On the TI-80, you enter an expression in the same order as you would write it.

You can create expressions on the Home screen to calculate an answer. In most places where a value is required, you can use an expression to enter the value.

Entering an Expression
To create an expression, you enter numbers, variables, and functions from the keyboard and menus. An expression is completed when you press \([\text{ENTER}]\), regardless of the cursor location. The entire expression is evaluated according to Equation Operating System (EOS™) rules, and then the answer is displayed.

Note: EOS rules determine the order in which operations are completed (page 1-20).

Most TI-80 functions and operations are symbols with several characters in them. You must enter the symbol from the keyboard or menu. You cannot spell it out. For example, to calculate the log of 45, you must press \([\text{LOG} \ 4 \ 5]\). You cannot type in the letters \(\text{LOG}\). (If you type \(\text{LOG}\), the TI-80 interprets the entry as implied multiplication of the variables \(L, O,\) and \(G\).)

Calculate \(3.76 \div (-7.9 + \sqrt{5}) + 2 \log_{45}\).

Multiple Entries on a Line
To enter more than one expression or instruction on a line, separate them with a colon (\(\:\)). They are all stored together in Last Entry (page 1-15).

1-6 Operating the TI-80
To enter a number in scientific notation:

1. Type the part of the number that precedes the exponent. This value can be an expression.

2. Press $2^\text{nd}$ [EE]. $\times10^n$ is displayed.

3. If the exponent is negative, press $\cdot$, and then type the exponent, which can be one or two digits.

\[1.5 \times 10^{-2} \quad 0.15\]

Entering a number in scientific notation does not cause the answers to be displayed in scientific notation. The display format is determined by the mode settings (pages 1-9 through 1-11) and the size of the number.

**Functions**

A function returns a value. For example, $+\times, -, \sqrt{}$, and $\log$ are functions. Some functions take more than one argument, which is indicated by a ( at the end of the name. $\min$ requires two arguments in this example: $\min(5,8)$.

**Instructions**

An instruction initiates an action. For example, $\text{clrdraw}$ is an instruction that clears any drawn elements from a graph. Instructions cannot be used in expressions. Some instructions take more than one argument, which is indicated by a ( at the end of the name. $\text{line}$ requires four arguments in this example: $\text{line}(1,1,3,3)$.

**Interrupting a Calculation**

While the busy indicator is displayed, indicating that a calculation or a graph is in progress, you can press $\begin{array}{c}0\end{array}$ to stop the calculation. (There may be a delay.)
### The Edit Keys

The arrow keys near the upper right of the keyboard control the movement of the cursor. In normal entry, a keystroke types over the character or characters at the position of the cursor. The `DEL` and `INS` keys delete or insert characters.

<table>
<thead>
<tr>
<th>Key(s)</th>
<th>Action(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 or 2</td>
<td>Moves the cursor within an expression. These keys repeat when you hold them down.</td>
</tr>
</tbody>
</table>
| 3 or 4       | Moves the cursor between lines within an expression. These keys repeat when you hold them down.  
  - On the top line of an expression on the Home screen, 3 moves the cursor to the beginning of the expression.  
  - On the bottom line of an expression on the Home screen, 4 moves the cursor to the end of the expression. |
| 5 or 6       | Moves the cursor to the beginning of an expression.                         |
| 7 or 8       | Moves the cursor to the end of an expression.                               |
| CLEAR        | On a line with text on the Home screen, clears (blanks) the current line.   
  - On a blank line on the Home screen, clears everything on the Home screen.  
  - In an editor, clears (blanks) the expression or value where the cursor is located; it does not store a zero. |
| DEL          | Deletes the character at the cursor. This key repeats.                     |
| 2nd [INS]    | Lets you insert characters at the underline cursor. To end insertion, press 2nd [INS] or a cursor key. |
| 2nd          | Next key press is a 2nd operation (the gold-colored label printed to the left above a key). The cursor changes to 1. To cancel 2nd, press 2nd again. |
| ALPHA        | Next key press is an ALPHA character (the light gray character to the right above a key). The cursor changes to A.  
  To cancel ALPHA, press ALPHA or a cursor key. |
| 2nd [A-LOCK] | Sets ALPHA-LOCK; each subsequent key press results in an ALPHA character. The cursor changes to A. To cancel ALPHA-LOCK, press ALPHA. |
| X,T          | Allows you to enter an X in FUNC mode or a T in PARAM mode without pressing ALPHA first. |
Setting Modes

Modes control how numbers and graphs are displayed and interpreted by the calculator. Mode settings are retained by the Constant Memory feature when the TI-80 is turned off.

Checking MODE Settings
Press [MODE] to display the MODE screen. The current settings are highlighted. The settings are described on the following pages.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORMAL</td>
<td>Numeric display format.</td>
</tr>
<tr>
<td>FLOAT</td>
<td>Number of decimal places.</td>
</tr>
<tr>
<td>RADIANS</td>
<td>Unit of angle measure.</td>
</tr>
<tr>
<td>&quot;a/b/c&quot;</td>
<td>Type of fraction display.</td>
</tr>
<tr>
<td>AUTOSIMP</td>
<td>Whether to simplify fractions.</td>
</tr>
<tr>
<td>FUNC</td>
<td>Type of graphing.</td>
</tr>
<tr>
<td>CONNECTED</td>
<td>Whether to connect graph points.</td>
</tr>
<tr>
<td>SEQUENTIAL</td>
<td>Whether to plot simultaneously.</td>
</tr>
</tbody>
</table>

Changing MODE Settings
To change the mode setting:
1. Press [ or ] to move the cursor to the line of the setting that you want to change. The setting that the cursor is on blinks.
2. Press [ or ] to move the cursor to the setting that you want.
3. Press [ENTER].

Leaving the MODE Screen
To leave the MODE screen:
• Press the appropriate keys to go to another screen.
• Press [2nd] [QUIT] or [CLEAR] to return to the Home screen.

Setting a Mode from a Program
You can set a mode from a program by entering the name of the mode as an instruction; for example, FUNC or FLOAT.
From a blank line in the program editor (Chapter 10), press [MODE] to display a menu of the mode names, and then select the name. The name is copied to the cursor location.
## TI-80 Modes

The TI-80 has eight mode settings. They control how numeric entries are interpreted, how answers are calculated or displayed, and how graphs appear in the display. Modes are set on the MODE screen (page 1-9).

<table>
<thead>
<tr>
<th>Mode</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NORMAL</strong></td>
<td>Notation formats affect only how an answer is displayed on the Home screen. Numeric answers can be displayed with up to 10 digits and a two-digit exponent. You can enter a number in any format.</td>
</tr>
<tr>
<td><strong>SCI</strong></td>
<td>(scientific) notation expresses numbers in two parts. The significant digits can be displayed with one digit to the left of the decimal. The appropriate power of 10 displays to the right of the decimal, as in 1.234567×4. Note: If you select normal display format, but the answer cannot be displayed in 10 digits or the absolute value is less than .001, the TI-80 displays the answer in scientific notation.</td>
</tr>
<tr>
<td><strong>FLOAT</strong></td>
<td>Decimal settings affect only how an answer is displayed on the Home screen. You can enter a number in any format. The decimal settings apply to both notation formats.</td>
</tr>
<tr>
<td><strong>Fixed Decimal</strong></td>
<td>Floating decimal setting displays up to 10 digits, plus the sign and decimal. The fixed decimal setting lets you select the number of digits (0 to 9) to be displayed to the right of the decimal. The displayed value is rounded based on the number of digits you selected. The actual value is stored and used in calculations. Place the cursor on the number of decimal digits you want, and press <strong>ENTER</strong>. Note: In the program editor, the format for fixed decimal settings is <strong>FIX n</strong>. Enter n as an integer from 0 to 9. The mode is changed to fixed decimal when the program is executed.</td>
</tr>
</tbody>
</table>
The angle mode controls:

- How the calculator interprets angle arguments in \( \text{SIN}, \text{COS}, \text{TAN} \), and polar-to-rectangular conversions.
- How the calculator returns angle answers to \( \text{SIN}^{-1}, \text{COS}^{-1}, \text{TAN}^{-1} \), and rectangular-to-polar conversions.

**Radian** mode interprets angle arguments as radians and returns angle answers in radians.

**Degree** mode interprets angle arguments as degrees and returns angle answers in degrees.

- \( \frac{a}{b} \div c \) displays fraction results as mixed numbers; for example, the result of \( \frac{1}{3} + \frac{4}{3} \) is displayed as \( 1 \frac{2}{3} \).
- \( \frac{b}{c} \) displays fraction results as simple fractions; for example, the result of \( \frac{1}{3} + \frac{4}{3} \) is displayed as \( \frac{5}{3} \).

**AUTOSIMP** automatically simplifies fraction results to their lowest terms before displaying them; for example, the result of \( \frac{2}{6} + \frac{2}{6} \) is displayed as \( \frac{2}{3} \).

**MANSIMP** displays fraction results without automatic simplification; for example, the result of \( \frac{2}{6} + \frac{2}{6} \) is displayed as \( \frac{4}{6} \).

**Func** (function) graphing plots functions where \( Y \) is expressed in terms of \( X \) (Chapter 4).

**Param** (parametric) graphing plots relations where \( X \) and \( Y \) are each expressed in terms of \( T \) (Chapter 5).

**Connected** draws line segments between the calculated points of the selected functions.

**Dot** plots only the calculated points of the selected functions.

**Sequential** graphing evaluates and plots one function completely before the next function is evaluated and plotted.

**Simul** (simultaneous) graphing evaluates and plots all selected functions for a single value of \( X \), one at a time. In Parametric mode, \( X \) and \( Y \) are selected pairs. They are evaluated and plotted a \( T \) value at a time.
### Variable Names

On the TI-80 you can enter, name, and use several types of data: numeric values (including fractions), lists, functions, and statistical plots.

#### Variables and Defined Items

The TI-80 uses both user-assigned and pre-assigned names for variables and other items saved in memory.

<table>
<thead>
<tr>
<th>Variable Type</th>
<th>Names</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numeric values (including fractions)</td>
<td>A, B, ..., Z, θ (single character only).</td>
</tr>
<tr>
<td>Lists</td>
<td>L1, L2, L3, L4, L5, L6 (on the keyboard).</td>
</tr>
<tr>
<td>Functions</td>
<td>Y1, Y2, Y3, Y4 (on the Y= editor in FUNC mode).</td>
</tr>
<tr>
<td>Parametric equations</td>
<td>X11/Y11, X21/Y21, X31/Y31 (on the Y= editor in PARAM mode).</td>
</tr>
<tr>
<td>Statistical plots</td>
<td>PLOT1, PLOT2, PLOT3 (on the STAT PLOTS menu).</td>
</tr>
<tr>
<td>System variables</td>
<td>XMIN, XMAX, and others (on various menus).</td>
</tr>
</tbody>
</table>

Programs have user-defined names also and share memory with variables. Program names can be up to seven characters long. Programs are entered and edited from the program editor (Chapter 10).

You can store to lists (Chapter 8), system variables such as XMAX (Chapter 4) or TBLMIN (Chapter 6), and all Y= functions (Chapters 4 and 5) from the Home screen or from a program. You can store to lists (Chapters 8 and 9) and functions (Chapters 4 and 5) from editors. You can also store to a list element (Chapter 8).

For more information about system variables, see Appendix A.
Values are stored to and recalled from memory using variable names. When an expression containing the name of a variable is evaluated, the value of the variable at that time is used.

**Storing Values in a Variable**

You can store a value to a variable from the Home screen or a program using the `STO>` key. Begin on a blank line.

1. Enter the value that you want to store (this can be an expression).
2. Press `STO>`. The symbol `>` is copied to the cursor location.
3. Press `ALPHA` and then the single letter of the variable to which you want to store the value.
4. Press `ENTER`. If you entered an expression, it is evaluated. The value is stored in the variable.

![Storing values in a variable](image)

**Displaying a Variable Value**

To display the value of a variable, enter the variable name on a blank line on the Home screen, and then press `ENTER`. You can enter the name of the variable in one of the following ways:

- Press `ALPHA` and the letter of the variable (for user-defined variables).
- Press `2nd` and the name of the list.
- Press `VARS` and select the type and name of the variable (for system variables).
- Press `2nd` `[Y-VARS]` and select the type and name of the function.

**Using a Variable in an Expression**

To use the current value of a variable in an expression, just enter the variable name in the expression.

![Using a variable in an expression](image)
**Last Entry**

When you press [ENTER] on the Home screen to evaluate an expression or execute an instruction, the expression or instruction is stored in an area called Last Entry, which you can recall. When you turn the TI-80 off, Last Entry is retained in memory.

**Using Last Entry**

You can recall Last Entry and edit it from the Home screen. Press [2nd] [ENTRY]. The current line is cleared, and the Last Entry is copied to the line. The cursor is positioned at the end of the entry. Because the TI-80 updates the Last Entry storage area only when you press [ENTER], you can recall the previous entry even if you have begun entering the next expression. However, when you recall Last Entry, it replaces what you have typed.

<table>
<thead>
<tr>
<th>5 4 7</th>
<th>5 + 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>(ENTER)</td>
<td>(2nd) [ENTRY]</td>
</tr>
</tbody>
</table>

**Displaying a Previous Entry**

The TI-80 keeps previous entries (up to a total of 80 bytes) in Last Entry. You can display and edit those entries by continuing to press [2nd] [ENTRY]. Last Entry displays previous entries in a loop, beginning with newest entry and moving to the oldest entry. Once the oldest item is displayed, [2nd] [ENTRY] displays the newest item again.

| 1 STO® ALPHA A | 1→A |
| 2 STO® ALPHA B | 2→B |
| 3 STO® ALPHA C | 3→C |

When you press [2nd] [ENTRY] again, the previous item replaces the item on the current line.

| 1→A | 1 |
| 2→B | 2 |
| 3→C | 3 |

| 2nd | ENTRY |

1-14 Operating the TI-80
Re-executing the Previous Entry

To execute Last Entry, press \[\text{ENTER}\] on a blank line on the Home screen. The entry is executed, but it does not display again.

```
0 \text{STO}\to\text{ ALPHA R}
\text{ENTER}
\text{STO}\to\text{ ALPHA N} + 1 \text{STO}\to\text{ ALPHA N}
\text{ENTER}
```

Multiple Entries on a Line

To enter more than one expression or instruction on a line, separate them with a colon (\(\text{:}\)). They are all stored together in Last Entry.

If the previous entry contained more than one expression or instruction, separated with a colon (page 1-6), they all are recalled. You can recall all entries on a line, edit any of them, and then execute all of them.

Using the equation \(A = \pi r^2\), use trial and error to find the radius of a circle that covers 200 square centimeters. Use 8 as your first guess.

```
8 \text{STO}\to\text{ ALPHA R [20]} \text{:}
\text{ENTER}
\text{STO}\to\text{ ALPHA R [3]} \text{:}
\text{ENTER}
```

Now try this.

```
\text{2nd} \times 7 \text{[2nd] [INS]} .95
\text{ENTER}
```

Continue until the answer is as accurate as you want.
When an expression is evaluated successfully from the Home screen or from a program, the TI-80 stores the answer to a variable, ANS (Last Answer). ANS may be a decimal number, a fraction, or a list. When you turn the TI-80 off, the value in ANS is retained in memory.

You can use the variable ANS to represent the last answer in most places. When you press \( \text{[ANS]} \), the variable name ANS is copied to the cursor location. When the expression is evaluated, the TI-80 uses the value of ANS in the calculation.

Calculate the area of a garden plot that is 1.7 meters by 4.2 meters. Then calculate the yield per square meter if the plot produces a total of 147 tomatoes.

\[
1.7 \times 4.2
\]

You can use the value in ANS as the first entry in the next expression without entering the value again or pressing \( \text{[ANS]} \). On a blank line on the Home screen, enter the function.

The TI-80 “types” the variable name ANS followed by the function.

To store an answer, store ANS to a variable before you evaluate another expression.

Calculate the area of a circle of radius 5 meters. Then calculate the volume of a cylinder of radius 5 meters and height 3.3 meters. Store the result in the variable \( V \).
To leave the keyboard uncluttered, the TI-80 uses full-screen menus to give you access to many additional operations. The use of specific menus is described in the appropriate chapters.

**Moving from One Menu to Another**

Some menu keys, such as MATH, display more than one menu. The names of the menus appear on the top line. The current menu is highlighted and the items in that menu are displayed.

Press 2 or 4 to move the cursor to a different menu.

**Selecting an Item from a Menu**

The number of the current item is highlighted. If there are more than seven items on the menu, a + appears on the last line in place of the ; (colon) between the menu number and name. Menu items, such as VARS WINDOW, that end in ... (ellipses marks) display another menu.

There are two methods of selecting from a menu.

- Press the number of the item you want to select.
- Press 4 and 7 to move the cursor to the item you want to select, and then press ENTER.

---

Calculate $3\sqrt{27}$.

1. Press [MATH] to display the MATH menu.

   ![MATH menu](image)

2. To select $3\sqrt{}$, you may either press 4 or press 2 7 ENTER.

3. Enter 27, and then press ENTER to evaluate the expression.
Leaving a Menu without Making a Selection

There are several ways to leave a menu without making a selection from the menu.

- To return to the Home screen, press [2ND] [QUIT].
- To return to the screen where you were, press [CLEAR].
- To display a different menu, press the appropriate key, such as [ZOOM].
- To select another screen, press the appropriate key, such as [WINDOW].
The VARS and Y-VARS Menus

You may want to use the names of system variables (such as XMIN) and functions (such as Y1) in an expression. You may also want to store values directly to those variables. Use the VARS or Y-VARS menus to access the names.

**VARS Menu**

The **VARS** menu displays the names of window variables such as XMIN and TSTEP, statistics variables such as $\bar{x}$ and Q1, and table variables such as TBLMIN.

Press [VARS] to display the **VARS** menu. Some of the items display more than one menu of variable names.

- **1: WINDOW**... Names of X, Y, and T variables.
- **2: STATISTICS**... X/Y, $\Sigma$, EQ, and BOX variables.
- **3: TABLE**... TBLMIN and $\Delta$TBL variables.
- **4: SIMPFAC**... Factor last used by $\text{\^{P}}\text{SIMP}$ function.

**Y-VARS Menu**

The **Y-VARS** menus display the names of functions and the instructions to select or deselect functions from a program or the Home screen.

Press [2nd] [Y-VARS] to display the **Y-VARS** menu. Then press [ENT] or [ALPHA] to select the type of variable you want.

- **Y** Displays a menu of names of Yn functions.
- **XT/YT** Displays a menu of names of XnT/YnT equations.
- **ON/OFF** Lets you select/deselect functions.

**Copying a Name from a VARS or Y-VARS Menu**

To copy a variable name from a **VARS** or **Y-VARS** menu:

1. Press [VARS] or [2nd] [Y-VARS]. The **VARS** or **Y-VARS** menu is displayed.
2. Select the type of variable you want.
3. Press [ENTER] to select the name you want from the menu. It is copied to the cursor location.
EOS (Equation Operating System)

The Equation Operating System (EOS™) defines the order of operations for the calculator—that is, the order in which the TI-80 evaluates functions in expressions. EOS lets you enter numbers and functions in a simple, straightforward sequence.

<table>
<thead>
<tr>
<th>Order of Evaluation</th>
<th>A function returns a value. EOS evaluates the functions in an expression in the following order.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Functions that are entered after the argument, such as $A^2$, $2^{-1}$, $22!$, $45^\circ$, $2\pi^7$, and $\text{SIMP}$.</td>
</tr>
<tr>
<td>2</td>
<td>Powers and roots, such as $2\sqrt[3]{5}$ or $5^\sqrt[3]{32}$.</td>
</tr>
<tr>
<td>3</td>
<td>Implied multiplication where the second argument is a number, variable name, or list, or begins with an open parenthesis, such as $4A$, $(A+B)4$, or $4(A+B)$.</td>
</tr>
<tr>
<td>4</td>
<td>Single-argument functions that precede the argument, such as $-A$, $\sqrt[3]{63}$, $\text{SIN}B$, or $\text{LOG} 3$.</td>
</tr>
<tr>
<td>5</td>
<td>Implied multiplication where the second argument is a multi-argument function or a single-argument function that precedes the argument, such as $2\text{NDERIV}(A^2,A,6)$ or $\text{ASIN} 2$.</td>
</tr>
<tr>
<td>6</td>
<td>Permutations ($nPr$) and combinations ($nCr$).</td>
</tr>
<tr>
<td>7</td>
<td>Multiplication and division (including $\text{INT}^\div$).</td>
</tr>
<tr>
<td>8</td>
<td>Addition and subtraction.</td>
</tr>
<tr>
<td>9</td>
<td>Test functions, such as $&gt;$ or $\leq$.</td>
</tr>
<tr>
<td>10</td>
<td>Conversion functions: $\text{FRAC}$, $\text{DEC}$, $\text{a}_b^c$, and $\text{b}_c^c$.</td>
</tr>
</tbody>
</table>

Within a priority group, EOS evaluates functions from left to right. However, two or more single-argument functions that precede the same argument are evaluated from right to left. For example, $\text{SIN FPART LN 8}$ is evaluated as $\text{SIN(FPART(LN 8))}$. Calculations within a pair of parentheses are evaluated first. Multi-argument functions, such as $\text{NDERIV}(A^2,A,6)$, are evaluated as they are encountered.

The conversion functions $\text{FRAC}$, $\text{DEC}$, $\text{a}_b^c$, and $\text{b}_c^c$ can be used only at the end of a command line with one exception: they can be followed by a store instruction.
Implied Multiplication

The TI-80 recognizes implied multiplication. For example, it understands $2\pi$, $4\sin 45$, $5(1+2)$, and $(2\times 5)7$ as implied multiplication.

Parentheses

All calculations inside a pair of parentheses are completed first. For example, in the expression $4(1+2)$, EOS first evaluates the portion inside the parentheses, $1+2$, and then multiplies the answer, 3, by 4.

You can omit any right (closing) parenthesis at the end of an expression. All “open” parenthetical elements are closed automatically at the end of an expression and preceding the $\Rightarrow$ (store) or display-conversion instructions.

Note: Parentheses are also used to enclose the arguments for certain functions, for example, $\text{NDERIV}(A^2,A,6)$. In these cases, parentheses do not indicate implied multiplication.

Negation

To enter a negative number, use the negation function. Press $\boxed{-}$, and then enter the number. On the TI-80, negation is in the fourth group in the EOS hierarchy. Functions in the first group, such as squaring, are evaluated before negation.

For example, $-X^2$ is a negative number (or 0); $-9^2$ is $-81$. Use parentheses to square a negative number: $(9)^2$.

```
-2^2       -4
( -2 )^2   4
-\text{A}^2 (-\text{A})^2  16
```

Note: Use the $\boxed{-}$ key for subtraction and the $\boxed{\text{(-)}}$ key for negation. If you press $\boxed{-}$ to enter a negative number, as in $9 \boxed{-}$ $7$, or if you press $\boxed{\text{(-)}}$ to indicate subtraction, as in $9 \boxed{\text{(-)}}$ $7$, it is an error. If you press $\boxed{\text{ALPHA}} \ A \ \boxed{\text{ALPHA}} \ B$, it is interpreted as implied multiplication ($A \times B$).
The TI-80 detects any errors at the time it evaluates an expression, executes an instruction, plots a graph, or stores a value. Calculations stop and an error message with a menu is displayed immediately. Error codes and conditions are described in detail in Appendix B.

### Diagnosing an Error

If the TI-80 detects an error, it displays the error screen.

![Error Screen](image)

The top line indicates the general type of error, such as **SYNTAX** or **DOMAIN**. For additional information about each error message, see Appendix B.

- If you select **GOTO**, the cursor is displayed at the location where the error was detected.
  
  **Note**: If a syntax error was detected in the contents of a \( Y= \) function during program execution, **GOTO** returns the user to the \( Y= \) editor, not to the program.

- If you select **QUIT**, or press \( 2 \text{nd} \ [ \text{QUIT} ] \) or **CLEAR**, you return to the Home screen.

### Correcting an Error

To correct an error:

1. Note the type of the error.

2. Select **GOTO**, if that option is available; and look at the expression for syntax errors, especially at and before the cursor location.

3. If the error in the expression is not readily apparent, turn to Appendix B, and read the information about the error message.

4. Correct the expression.
This chapter describes the math, angle, and relational operations that are available on the TI-80. The most commonly used functions are accessed from the keyboard; others are accessed through menus.

<table>
<thead>
<tr>
<th>Chapter Contents</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Getting Started: Lottery Chances</td>
<td>2-2</td>
</tr>
<tr>
<td>Using the TI-80 Functions</td>
<td>2-3</td>
</tr>
<tr>
<td>Keyboard Math Operations</td>
<td>2-4</td>
</tr>
<tr>
<td>MATH MATH Operations</td>
<td>2-7</td>
</tr>
<tr>
<td>MATH NUM (Number) Operations</td>
<td>2-10</td>
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<tr>
<td>MATH PRB (Probability) Operations</td>
<td>2-12</td>
</tr>
<tr>
<td>ANGLE Operations</td>
<td>2-14</td>
</tr>
<tr>
<td>TEST (Relational) Operations</td>
<td>2-16</td>
</tr>
</tbody>
</table>
Suppose you want to enter a lottery where six numbers will be drawn out of 50. To win, you must pick all six numbers (in any order). What is the probability of winning if you buy one ticket? What is the probability of winning if you buy five tickets?

1. Determine the number of combinations possible. On the Home screen, press 50 to enter the total number of items. Press MATH 4 to display the MATH PRB menu. Press 3 to select nCr. Press 6 to enter the number of items selected.

2. Press [ENTER] to evaluate the expression. This is the total number of possible combinations of 6 numbers drawn from a set of 50 numbers. With one ticket, you have one chance in 15,890,700 of winning.

3. To calculate the probability of winning with one ticket, press 1 [1 É 2nd [ANS] [ENTER]. The answer is too large to display in fixed notation; therefore, it is shown in scientific notation. 0.0000000629298881 is the decimal equivalent.

4. To calculate the probability of winning with five tickets, press 5 [ENTER]. Again, the answer is too small to display in fixed notation. The decimal equivalent is 0.00000314649449.
## Using the TI-80 Functions

This page contains some general information you should know about the TI-80 functions described in Chapter 1.

### Using Lists with Functions

Functions that are valid for lists return a list calculated on an element-by-element basis. If two lists are used in the same expression, they must be the same length. For more information about lists, see Chapter 8.

\[
\begin{array}{c}
{1, 2} + {3, 4} \\
2 \times {4, 5} \\
\end{array}
\]

### Using Fractions with Functions

Some math functions (+, −, ×, ÷, \(\sqrt{\cdot}\), \(\text{a} \div \text{b} / \text{c}\), \(\text{DEC}\)) accept fractions as input values. All other functions convert fractions to decimals before operating on them. For more information about fractions, see Chapter 3.

\[
\begin{array}{c}
1 \#2 + 1 \#3 \\
\sin 1 \#2 \\
1 \#9 \\
\end{array}
\]
Keyboard Math Operations

The most commonly used math functions are on the keyboard. The keyboard math operations can be used with decimal numbers, fractions (except as noted), expressions, and lists.

| + (Add) | The basic arithmetic functions are: addition $+$, subtraction $-$, multiplication $\times$, and division $\div$. Each argument for these functions can be a list. |
| − (Subtract) |
| × (Multiply) |
| / (Divide) |

```
7+5-3*2 = 6
12+3=31+2=36
3 5
```

Trig Functions

The trigonometric functions are interpreted according to the current RADIAN/DEGREE mode setting. (Refer to page 1-9 for instructions on changing the mode setting.) For example, $\text{SIN 30}$ in RADIAN mode returns $0.9880316241$; in DEGREE mode, it returns $0.5$. Each argument for the trigonometric functions may be a list.

$\text{SIN value, COS value, TAN value}$

$\text{SIN}^{-1}, \text{COS}^{-1},$ and $\text{TAN}^{-1}$ are the inverse trig functions (arcsine, arccosine, and arctangent).

$\text{SIN}^{-1} \text{ value, COS}^{-1} \text{ value, TAN}^{-1} \text{ value}$

RADIAN Mode

| $\text{SIN} \left( \frac{\pi}{2} \right)$ |
| $\text{COS} \left( \frac{\pi}{2} \right)$ |
| $\text{TAN} \left( \frac{\pi}{2} \right)$ |
| $\sin \frac{\pi}{2} = 1$ |
| $\cos \frac{\pi}{2} = 0$ |
| $\tan \frac{\pi}{2}$ $=$ undefined |

$^{-1}$ (Inverse)

$^{-1}$ (inverse, $\div$) may be used with numbers, expressions, or lists. The multiplicative inverse is the equivalent of the reciprocal, $1/x$.

$\text{value}^{-1}$

```
5^-1 = 0.2
```

2-4 Math, Angle, and Test Operations
\( ^\text{(Power)} \), \( ^2 \text{(Square)} \), and \( \sqrt{\text{(Square Root)}} \) may be used with decimal numbers, fractions, expressions, or lists. When used with a fraction, \( \sqrt{\text{(Square Root)}} \) returns a decimal number.

**Note:** Raising a negative number to a noninteger power can result in a complex number, which returns an error.

\[
\begin{array}{c|c}
\text{Value} & \text{Result} \\
25 & 625 \\
\text{FAH} & 25 \\
2 & \\
\{1, 2, 3\} & \\
\{1, \text{B}, 273\} & \\
\end{array}
\]

These functions find the logarithm \( \log \), power of ten \( 10^\text{power} \), and natural log \( \ln \) of the specified value or list of values.

\[
\begin{array}{c|c}
\text{LOG} & 66 \\
\text{10}^\text{power} & 1.819543936 \\
\text{LN} & 66 \\
\{1, 2\} & \\
\{10, 1.471806\} & \\
\end{array}
\]

\( e^\text{(power)} \) returns the constant \( e \) raised to a power or list of powers. \( e^1 \) returns the value of the constant \( e \).

\[
\begin{array}{c|c}
\text{e}^\text{power} & \\
6 & 1.484131591 \\
\text{e}^1 & 2.718281828 \\
\end{array}
\]
(Negation) 

- (negation, \(\bar{)}\) returns the negative of a number, expression, or list. The narrow negation symbol (\(\bar{)}\) distinguishes negation from the subtraction or minus (\(-\)).

\(-value\)

EOS rules (Chapter 1) determine when negation is evaluated. For example, \(-A^2\) returns a negative number because squaring is evaluated before negation. Use parentheses to square a negated number, \((-A)^2\).

\[ (-2)^2 = 4 \]

ABS

ABS (absolute value, \(\text{\textasciitilde\text{ABS}}\)) returns the absolute value of a number, expression, or list.

\(\text{ABS value}\)

\[ \text{ABS} \neg 256 \]
\[ \text{ABS} \{1.25, \neg 5.67\} \]
\[ 1.25 \quad 5.67 \]

\(\pi (\text{Pi})\)

\(\pi\) (\(\text{\textasciitilde\text{\pi}}\)) is stored as a constant in the TI-80. Press \(\text{\textasciitilde\text{\pi}}\) to copy the symbol \(\pi\) to the cursor location. The number 3.141592654 is displayed for \(\pi\), but 3.1415926535898 is used internally in calculations.

\[ \text{\textasciitilde\text{\pi}} \]
\[ 6.283185307 \]
\[ 19.53981634 \]
MATH MATH Operations

To display the MATH MATH menu, press \texttt{MATH}. When you select a menu item, the name is copied to the cursor location. Functions that are valid for lists return a list calculated on an element-by-element basis.

<table>
<thead>
<tr>
<th>MATH MATH Menu</th>
<th>MATH</th>
<th>NUM</th>
<th>PRB</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: INT$\div$</td>
<td>Displays quotient and remainder.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2: \texttt{DEC}</td>
<td>Displays answer in decimal form.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3: \texttt{3}</td>
<td>Cube.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4: \texttt{\sqrt{}}</td>
<td>Cube root.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5: \texttt{\sqrt[n]{}}</td>
<td>(n^{th}) root.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6: \texttt{NDERIV}</td>
<td>Numerical derivative.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**INT$\div$**

On the Home screen or from a program, INT$\div$ (integer divide, MATH MATH, item 1) returns the quotient (or quotient and remainder) resulting from the division of two integers. Each argument can be a list.

\[
\text{integerA} \text{INT} \text{integerB}
\]

When INT$\div$ is executed on the Home screen, it displays the symbols \(Q=\) for the quotient and \(R=\) for the remainder.

**Note:** If INT$\div$ is embedded in an expression, \(Q=\) and \(R=\) may not be displayed.

When used with lists, INT$\div$ returns a list of quotients only.

If the result of INT$\div$ is used in subsequent calculations, the remainder is dropped, and only the quotient is used.

The quotient from INT$\div$ is returned to ANS.
\( \text{DEC} \) (convert to decimal, MATH MATH, item 2) displays an answer in decimal form. \( \text{DEC} \) can only be used after a value and at the end of an expression. value can be a list.

value\( \text{DEC} \)

expression\( \text{DEC} \)

\[
\begin{array}{c|c}
\text{1.2+1.3} & 5.6 \\
\hline
\text{ANS}\text{DEC} & 833333333333
\end{array}
\]

\( ^3 \) (Cube)  
\( 3 \) (cube, MATH MATH, item 3) returns the cube of a number, expression, or list.

value

\[
\{2,3,4,5\}^3
\]

\( ^3 \sqrt{} \) (Cube Root)  
\( 3 \sqrt{} \) (cube root, MATH MATH, item 4) returns the cube root of a number, expression, or list.

\( 3 \sqrt{} \text{value} \)

\[
\{8,27,64,125\}
\]

\( ^n \sqrt{} \) (Root)  
\( n \sqrt{} \) (root, MATH MATH, item 5) returns the \( n^{th} \) real root of a number, expression, or list.

\( n^{th}\text{root}^\sqrt{} \text{value} \)

\[
\{\sqrt[4]{1,16,81}\}
\]
NDERIV( (numerical derivative, MATH MATH, item 6) returns an approximate derivative of an expression with respect to a specified variable, given the value at which to calculate the derivative, and \( \varepsilon \) (optional; if none is specified, \( 1 \times 3 \) is used).

NDERIV(expression, variable, value) or NDERIV(expression, variable, value, \( \varepsilon \))

NDERIV( uses the symmetric difference quotient method (as shown in the formula below), which approximates the numerical derivative value as the slope of the secant line through the points:

\[
f'(x) = \frac{f(x+\varepsilon)-f(x-\varepsilon)}{2\varepsilon}
\]

As \( \varepsilon \) gets smaller, the approximation usually gets more accurate.

Because of the method used, NDERIV( can return a false derivative value at a nondifferentiable point.
MATH NUM (Number) Operations

To display the MATH NUM menu, press [MATH] 9. When you select a menu item, the name is copied to the cursor location. Functions that are valid for lists return a list calculated on an element-by-element basis.

<table>
<thead>
<tr>
<th>MATH NUM Menu</th>
<th>MATH NUM PRB</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: ROUND(</td>
<td>Round.</td>
</tr>
<tr>
<td>2: IPART</td>
<td>Integer part.</td>
</tr>
<tr>
<td>3: FPART</td>
<td>Fractional part.</td>
</tr>
<tr>
<td>4: INT</td>
<td>Greatest integer.</td>
</tr>
<tr>
<td>5: MIN(</td>
<td>Minimum value.</td>
</tr>
<tr>
<td>6: MAX(</td>
<td>Maximum value.</td>
</tr>
<tr>
<td>7: REMAINDER(</td>
<td>Remainder of a division result.</td>
</tr>
</tbody>
</table>

ROUND(

ROUND( (MATH NUM, item 1) returns a number, expression, or list rounded to a specified number of decimals (≤9). If the number of decimals is omitted, the number is rounded to the digits that are displayed, a maximum of 10 digits.

<table>
<thead>
<tr>
<th>Round(value, #decimals)</th>
<th>Round(value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROUND(π, 4)</td>
<td>123456789012-3\E</td>
</tr>
<tr>
<td>ROUND(π2, 5)</td>
<td>123456789012-13\E</td>
</tr>
<tr>
<td>{3.1, 3.14, 3.142}</td>
<td>123456789012-13\E</td>
</tr>
</tbody>
</table>

IPART

IPART (integer part, MATH NUM, item 2) returns the integer part or parts of a number, expression, or list. FPART (fractional part, MATH NUM, item 3) returns the fractional part or parts of a number, expression, or list.

<table>
<thead>
<tr>
<th>IPART value</th>
<th>FPART value</th>
</tr>
</thead>
<tbody>
<tr>
<td>-23.45</td>
<td>-23.45</td>
</tr>
<tr>
<td>5.25</td>
<td>5.25</td>
</tr>
<tr>
<td>{5.25, 2.62}</td>
<td>{5.25, 2.62}</td>
</tr>
<tr>
<td>23.45</td>
<td>23.45</td>
</tr>
</tbody>
</table>

INT

INT (greatest integer, MATH NUM, item 4) returns the largest integer less than or equal to a number, expression, or list. The value is the same as IPART for nonnegative numbers and negative integers, but one integer less than IPART for negative noninteger numbers.

<table>
<thead>
<tr>
<th>INT value</th>
</tr>
</thead>
<tbody>
<tr>
<td>-23.45</td>
</tr>
<tr>
<td>23.45</td>
</tr>
<tr>
<td>23</td>
</tr>
</tbody>
</table>
**MIN**

**MIN** (minimum value, **MATH NUM**, item 5) returns the smaller of two values or the smallest element in a list. If two lists are compared, it returns a list of the smaller of each pair of elements. If a list and a value are compared, it compares each element in the list to the value.

**MAX**

**MAX** (maximum value, **MATH NUM**, item 6) returns the larger of two values or the largest element in a list. If two lists are compared, it returns a list of the larger of each pair of elements. If a list and a value are compared, it compares each element in the list to the value.

\[
\text{MIN}(valueA, valueB) \quad \text{MAX}(valueA, valueB) \\
\text{MIN}(list) \quad \text{MAX}(list) \\
\text{MIN}(listA, listB) \quad \text{MAX}(listA, listB) \\
\text{MIN}(value, list) \quad \text{MAX}(value, list) \\
\text{MIN}(list, value) \quad \text{MAX}(list, value)
\]

**Note:** **MIN** and **MAX** are also available on the **LIST MATH** menu.

**REMAINDER**

**REMAINDER** (MATH NUM, item 7) returns the remainder resulting from the division of two integers, each of which can be a list. (See **INT÷**, page 2–7.)

\[
\text{REMAINDER}(valueA, valueB) \quad \text{REMAINDER}(listA, listB) \\
\text{REMAINDER}(value, list) \quad \text{REMAINDER}(list, value)
\]

If a list is used as one or both arguments, the result is a list of remainders.

\[
\begin{align*}
\text{REMAINDER}(10, 4) & \quad 2 \\
\text{REMAINDER}(15, 18) & \quad 3 \quad \text{REM} \quad 15, 18 \\
\text{REMAINDER}(17, 5) & \quad 2 \quad \text{REM} \quad 17, 5 \\
\end{align*}
\]
MATH PRB (Probability) Operations

To display the MATH PRB menu, press \text{MATH} \, 6. When you select a menu item, the name is copied to the cursor location. Functions that are valid for lists return a list calculated on an element-by-element basis.

<table>
<thead>
<tr>
<th>MATH PRB Menu</th>
<th>MATH NUM</th>
<th>PRB</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: RAND</td>
<td>Random number generator.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2: nPr</td>
<td>Number of permutations.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3: nCr</td>
<td>Number of combinations.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4: !</td>
<td>Factorial.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5: RANDINT(</td>
<td>Random integer generator.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**RAND** (random number, MATH PRB, item 1) generates and returns a random number greater than 0 and less than 1 (as in the first example below). A random number is generated from a seed value. To control a random number sequence, first store an integer seed value in RAND. In the second example below, 1 is stored to RAND so that the TI-80 uses 1 as the seed value for generating random numbers.

<table>
<thead>
<tr>
<th>RAND</th>
<th>I&gt;RAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.59586052</td>
<td>6049938543</td>
</tr>
<tr>
<td>0.468559858</td>
<td>876572391</td>
</tr>
<tr>
<td>0.775434854</td>
<td>203632363</td>
</tr>
<tr>
<td>0.528931544</td>
<td>803989702</td>
</tr>
<tr>
<td>1</td>
<td>0.07661959</td>
</tr>
</tbody>
</table>

Note: When you reset the TI-80, RAND is set to the factory seed value, which is 0.
### nPr

*nPr* (number of permutations, **MATH PRB**, item 2) returns the number of **permutations** of **items** taken **number** at a time. **items** and **number** must be nonnegative integers. Both **items** and **number** can be lists.

### nCr

*nCr* (number of combinations, **MATH PRB**, item 3) returns the number of **combinations** of **items** taken **number** at a time. **items** and **number** must be nonnegative integers. Both **items** and **number** can be lists.

### ! (Factorial)

*!* (factorial, **MATH PRB**, item 4) returns the factorial of a positive integer or list of integers between 0 and 69.

### RANDINT

**RANDINT** (random integer, **MATH PRB**, item 5) generates a random integer within a specified range. It requires two arguments: the lower and upper boundaries of the range (in any order). Both arguments must be integers. Both arguments can be negative. Both arguments can be lists.

<table>
<thead>
<tr>
<th>nPr</th>
<th>nCr</th>
<th>! (Factorial)</th>
<th>RANDINT</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 nPr 2</td>
<td>5 nCr 2</td>
<td>10</td>
<td>RANDINT(1, 5)</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>{2, 33} nCr {2, 2}</td>
<td>{1, 33}</td>
<td>4</td>
<td>RANDINT(1, 5)</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>{1, 33}</td>
<td>{1, 33}</td>
<td>4</td>
<td>RANDINT(1, 5)</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>
### ANGLE Operations

To display the ANGLE menu, press \[ \text{2nd} \ [\text{ANGLE}] \]. The ANGLE menu displays angle indicators and instructions. When you select an item from the menu, the name is copied to the cursor location.

<table>
<thead>
<tr>
<th>ANGLE Menu</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: °</td>
<td>Degree notation.</td>
</tr>
<tr>
<td>2: r</td>
<td>Radian notation.</td>
</tr>
<tr>
<td>3: ( \text{R} \rightarrow \text{P} )</td>
<td>Returns ( r ), given ( X ) and ( Y ).</td>
</tr>
<tr>
<td>4: ( \text{R} \rightarrow \theta )</td>
<td>Returns ( \theta ), given ( X ) and ( Y ).</td>
</tr>
<tr>
<td>5: ( \text{P} \rightarrow \text{R} )</td>
<td>Returns ( x ), given ( R ) and ( \theta ).</td>
</tr>
<tr>
<td>6: ( \text{P} \rightarrow \text{Y} )</td>
<td>Returns ( y ), given ( R ) and ( \theta ).</td>
</tr>
</tbody>
</table>

**° (Degree)**

° (degree, ANGLE, item 1) lets you designate an angle or list of angles as degrees, regardless of the current angle mode setting. In Radian mode, ° can also be used to convert degrees to radians.

#### value°

<table>
<thead>
<tr>
<th>Radian Mode</th>
<th>DEGREE Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \sin 45° )</td>
<td>( 45° )</td>
</tr>
<tr>
<td>( \sin 0, 30, 90° )</td>
<td>( 0, 5, 1 )</td>
</tr>
</tbody>
</table>

**r (Radians)**

r (radians, ANGLE, item 2) lets you designate an angle or list of angles as radians, regardless of the current angle mode setting. In Degree mode, r can also be used to convert radians to degrees.

#### valuer

<table>
<thead>
<tr>
<th>DEGREE Mode</th>
<th>Radian Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \sin \frac{\pi}{4} )</td>
<td>( \frac{\pi}{4} )</td>
</tr>
<tr>
<td>( \sin 45° )</td>
<td>( 45° )</td>
</tr>
</tbody>
</table>
**Note:** When converting from one coordinate system to the other, be sure that the angle mode setting, **DEGREE** or **RADIANS**, is appropriate for your angle measurements. (Press **MODE** to check the current setting.)

**R»Pr** (*ANGLE*, item 3) converts the given rectangular coordinates to polar coordinates and returns \( r \).

**P»Rx** (*ANGLE*, item 5) converts the given polar coordinates to rectangular coordinates and returns \( x \).

Both \( X \) and \( Y \) can be lists.

\[
R»Pr(X, Y) \\
P»Rx(X, Y)
\]

**R»Pr**

\[
\begin{array}{c|c}
1 & 1 \\
3.141592654 & 3.141592654
\end{array}
\]

**P»Rx**

\[
\begin{array}{c|c}
1 & 1 \\
0 & 0
\end{array}
\]
TEST Menu

<table>
<thead>
<tr>
<th>TEST</th>
<th>True if:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: =</td>
<td>Equal.</td>
</tr>
<tr>
<td>2: ≠</td>
<td>Not equal to.</td>
</tr>
<tr>
<td>3: &gt;</td>
<td>Greater than.</td>
</tr>
<tr>
<td>4: ≥</td>
<td>Greater than or equal to.</td>
</tr>
<tr>
<td>5: &lt;</td>
<td>Less than.</td>
</tr>
<tr>
<td>6: ≤</td>
<td>Less than or equal to.</td>
</tr>
</tbody>
</table>

Relational operators compare valueA and valueB and return 1 if the test is true or 0 if the test is false. valueA and valueB can be numbers, expressions, or lists.

Relational operators are often used in programs to control program flow and in graphing to control the graph of a function over specific values.

- valueA=valueB
- valueA≠valueB
- valueA>valueB
- valueA≥valueB
- valueA<valueB
- valueA≤valueB

Using Tests

Relational operators are evaluated after mathematical functions according to EOS rules (Chapter 1).

- The expression 2+2=2+3 returns 0. The TI-80 does the addition first because of EOS rules, and then it compares 4 to 5.
- The expression 2+(2×2)+3 returns 6. The TI-80 first performs the relational test because it is in parentheses; then it adds 2, 1, and 3.
Chapter 3: Fractions

This chapter describes how to use the fraction operations on the TI-80.

<table>
<thead>
<tr>
<th>Chapter Contents</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Getting Started: Working with Fractions</td>
<td>3-2</td>
</tr>
<tr>
<td>Setting Modes for Fraction Results</td>
<td>3-4</td>
</tr>
<tr>
<td>Entering and Using Fractions in Calculations</td>
<td>3-6</td>
</tr>
<tr>
<td>The FRACTION Menu</td>
<td>3-8</td>
</tr>
</tbody>
</table>
Getting Started is a fast-paced introduction. Read the chapter for details.

Enter the expression $1 \frac{6}{27} + 1 \frac{1}{9}$. Evaluate the expression, simplify the result, and then use the conversion options on the FRACTION menu to convert the result.

This example is performed in MANSIMP (manual simplification) mode. MANSIMP mode is especially useful for students when they are learning fraction concepts. When MANSIMP mode is selected, the $\text{SIMP}$ function (from the FRACTION menu) can be used to simplify fractions step-by-step.

1. Select MANSIMP mode.

2. From the Home screen, press $\frac{1}{2} \frac{6}{27} \frac{1}{1} \frac{1}{9}$ to enter the mixed-fraction expression, $1 \frac{6}{27} + 1 \frac{1}{9}$.

3. Press $\downarrow$ to evaluate the expression. The $\downarrow$ indicates that the fraction can be simplified.

4. Press $\text{Frac}$ to select $\text{SIMP}$ (simplify). ANS$\text{SIMP}$ is copied to the cursor location.

5. Press $\downarrow$ to simplify the fraction.

In MANSIMP mode, the TI-80 uses the lowest common factor for simplification. The simplification factor is displayed. The $\downarrow$ preceding the result indicates that the fraction can be simplified further. Continue pressing $\downarrow$ until $\downarrow$ is no longer displayed.

---

3-2 Fractions
The TI-80 uses the lowest common factor for simplification. If you want to choose the simplification factor yourself, you can enter it as part of the expression.

6. Press CLEAR to clear the screen. Reenter the expression, or press [2nd] [ENTRY] until you see the expression $1\frac{6}{27} + 1\frac{1}{9}$.

7. Press [2nd] [INS] [2nd] [9]. This adds the simplification factor 9 and places the expression in parentheses.

8. Press [FRAC] 1 to copy ▶SIMP to the cursor location.

9. Press ' to simplify the fraction result. The simplification factor is displayed.

10. Press [2nd] [ANS] [FRAC] 2 [ENTER] to convert the mixed fraction result to a simple fraction.

11. Press [2nd] [ANS] [FRAC] 5 [ENTER] to convert the fraction result to its decimal equivalent.
Setting Modes for Fraction Results

From the MODE screen, you can select simplification and display format options for fraction results.

**AUTOSIMP Mode with b/c and a.b/c Modes**

**AUTOSIMP** mode simplifies fractions automatically. Simplification takes place before the expression is evaluated. Then the result is simplified to its lowest terms. For example, \( \frac{12}{16} \) is simplified to \( \frac{3}{4} \) when you press \( \text{Enter} \).

There are two formats for displaying fractions results.

- **b/c** mode displays fraction results in simple-fraction (a fraction without a whole number) format; for example, \( \frac{25}{4} \).

\[
\begin{align*}
\text{b/c} & : \frac{25}{4} \\
\text{a.b/c} & : 5 \frac{3}{4}
\end{align*}
\]

- **a.b/c** displays fraction results in mixed-fraction (a whole number with a fraction) format; for example \( 5 \frac{3}{4} \).
MANSIMP Mode

MANSIMP mode lets you simplify fractions manually. MANSIMP was designed for teaching and learning fractions concepts. In MANSIMP mode, you can simplify fractions and the results of expressions using fractions, step-by-step.

When a fraction result is not expressed in its lowest terms, a down arrow (↓) is displayed to remind you that you can simplify the result. Use SIMP from the FRACTION menu to simplify the fraction. You can then use → or → to change the display format of the fraction result.

Typically, you use the MANSIMP simplification mode with the → display format mode for teaching or learning fraction concepts. The display format of fraction results can vary when you are using MANSIMP and →.
- When you simply enter a fraction and press [ENTER], the format in which you entered the fraction is preserved.

\[\frac{25}{100} + \frac{25}{50} = \frac{75}{100}\]
\[\text{ANS:} \frac{3}{4}\]

- When you add or subtract using a mixed fraction, calculation takes place on the whole-number and fractional part of the mixed-fraction separately. The result is displayed as a mixed fraction.

\[1 \frac{2}{3} + 2 \frac{2}{4} = 3 \frac{3}{4}\]

- When you multiply or divide using a mixed fraction, the result is displayed as a simple fraction.

\[1 \frac{1}{2} \times 2 \frac{1}{3} = 2 \frac{1}{6}\]
### Entering and Using Fractions in Calculations

The TI-80 lets you enter fractions directly from the keyboard.

#### Entering Simple Fractions
A simple fraction is a fraction with no whole-number part; for example, \( \frac{3}{4} \) or \( \frac{4}{3} \).

To enter a simple fraction:

1. Enter the numerator (up to six digits), and then press \( \frac{2}{4} \).
2. Enter the denominator (up to and including 1000).

For example, press \( 2 \frac{2}{3} \) to enter \( \frac{2}{3} \).

#### Entering Mixed Fractions
A mixed fraction is a fraction that has both a whole-number and a fractional part; for example \( 1 \frac{1}{3} \).

To enter a mixed fraction:

1. Enter the units (up to three digits), and then press \( \frac{2}{3} \).
2. Enter the numerator (up to three digits), and then press \( \frac{2}{3} \).
3. Enter the denominator (up to and including 1000).

For example, press \( 5 \frac{2}{3} \) to enter \( 5 \frac{2}{3} \).
In general, you can use fractions in expressions just as you would use other numbers. The results of the expressions, however, may or may not be fractions.

**Using Fractions in Expressions**

The absolute value of a fraction on the TI-80 cannot be ≥1000. \( \div, \times, \square, \sqrt[3]{\,}, \diamond \), and \( \boxed{\text{ABS}} \) accept fraction entries and return fraction results. If the absolute value of a fraction result is ≥1000, or if the results of operations with these functions are not within the limits shown on page 3-6, the results are given in decimal form.

Other functions accept fraction entries, but convert them to decimal form before operating on them. The results are given in decimal form. For example, \( \sqrt{4/9} \) returns .6666666667, not \( 2/3 \).

If you use \( \boxed{\text{SIMP}} \) with a fraction that has been converted to a decimal, an error occurs.

If an expression contains both a fraction and a decimal number, the result is displayed as a decimal number.

You can also enter fractions in a list, but the results are returned as decimal values.

\[
\begin{array}{c}
\frac{1}{2}+\frac{1}{2} \rightarrow 1 \times 0.5 \\
\frac{1}{2}-1 \rightarrow 1 \times 0.5 \\
\{\frac{1}{4}, \frac{2}{4}, \frac{3}{4}\} \rightarrow \{\times 0.5, \times 0.5, \times 0.5\}
\end{array}
\]
To display the FRACTION menu, press \texttt{Frac}. The menu items let you simplify and convert fractions. When you select a menu item, the name is copied to the cursor location.

**FRACTION Menu**

```
1: \texttt{SIMP}  Simplifies the fraction.
2: \texttt{b/c}  Converts to a simple fraction.
3: \texttt{a_b/c}  Converts to a mixed fraction.
4: \texttt{FRAC}  Converts a decimal to a fraction based on mode.
5: \texttt{DEC}  Converts a fraction to a decimal.
```

\textbf{Simplifying Fractions} \texttt{\textbackslash SIMP}

\texttt{\textbackslash SIMP} (simplify fraction, \texttt{FRACTION}, item 1) simplifies the specified fraction and displays it, along with the simplification factor.

\textbf{Note:} \texttt{\textbackslash SIMP} can only be used in \texttt{MANSIMP} mode.

You have two options for simplifying fractions.

- You can let the calculator simplify the fraction, step-by-step, using the lowest common factor (LCF).

  \textit{fraction}\texttt{\textbackslash SIMP}

  \begin{verbatim}
  \frac{10}{100}\texttt{\textbackslash SIMP}
  \begin{array}{l}
  \text{FACTOR} = 2 \quad 0.1 \text{ simplifies to } 0.1 \text{, and so on.}
  \end{array}
  \end{verbatim}

- You can choose a factor (an integer) for simplifying the fraction.

  \textit{\textbackslash SIMP}\texttt{\langle fraction, factor\rangle}

  \begin{verbatim}
  \frac{10}{100}\texttt{\langle 5, \textbackslash SIMP\rangle}
  \begin{array}{l}
  \text{FACTOR} = 5 \quad 0.02 \text{ simplifies to } 0.02 \text{, and so on.}
  \end{array}
  \end{verbatim}

Both simplification options update the variable \texttt{FACTOR}.

---

3-8 Fractions
Converting Simple and Mixed Fractions

►b/c (convert to simple fraction, FRACTION, item 2) converts value to a simple fraction.

►a.b/c (convert to mixed fraction, item 3) converts value to a mixed fraction.

value►b/c
value►a.b/c

<table>
<thead>
<tr>
<th>▶b/c</th>
<th>▶a.b/c</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1</td>
<td>1.1</td>
</tr>
<tr>
<td>2/3</td>
<td>0.66666</td>
</tr>
<tr>
<td>5/2</td>
<td>2.5</td>
</tr>
<tr>
<td>11/2</td>
<td>5.5</td>
</tr>
</tbody>
</table>

Both ▶b/c and ▶a.b/c can be used only at the end of an expression. A ▶(STO+) instruction, however, can follow them.
Converting Decimals and Fractions

►FRAC (convert to fraction, FRACTION, item 4) converts a decimal value to its fraction equivalent and displays it. The decimal may be a number, expression, or list.

In MANSIMP mode, ►FRAC first attempts to return a fraction in terms of 10ths, 100ths, or 1000ths. If this is not possible, ►FRAC converts the decimal to its fraction equivalent as it would in AUTOSIMP mode. If the value cannot be converted or if the denominator of the equivalent fraction is greater than 1000, the decimal equivalent is returned.

The form of the ►FRAC result depends on the current fraction display format. For example, 1.25 ►FRAC returns 1 1/4 if \( \frac{a}{b} \) is selected or \( \frac{5}{4} \) if \( b/c \) is selected.

If the decimal value for ►FRAC is a list, the list is displayed as fractions, but it is still stored internally in decimal form.

►DEC (convert to decimal, FRACTION, item 5) converts a fraction value to its decimal form and displays it.

decimal►FRAC

fraction►DEC

<table>
<thead>
<tr>
<th>AUTOSIMP &amp; ( \frac{a}{b} )</th>
<th>AUTOSIMP &amp; ( \frac{b}{c} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{10}{100} )</td>
<td>( \frac{5}{10} )</td>
</tr>
<tr>
<td>Ans►DEC</td>
<td>Ans►DEC</td>
</tr>
<tr>
<td>1.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Ans►Frac</td>
<td>Ans►Frac</td>
</tr>
<tr>
<td>1.4</td>
<td>0.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MANSIMP &amp; ( \frac{a}{b} )</th>
<th>MANSIMP &amp; ( \frac{b}{c} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{10}{100} )</td>
<td>( \frac{18}{10} )</td>
</tr>
<tr>
<td>Ans►DEC</td>
<td>Ans►DEC</td>
</tr>
<tr>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td>Ans►Frac</td>
<td>Ans►Frac</td>
</tr>
<tr>
<td>1.8</td>
<td>1.8</td>
</tr>
</tbody>
</table>

Both ►FRAC and ►DEC are valid only at the end of an expression. A ► (STO) instruction, however, can follow them.

3-10 Fractions
Chapter 4: Function Graphing

This chapter describes function graphing on the TI-80 in detail. It also lays the foundation for using the parametric graphing features described in Chapter 5.

<table>
<thead>
<tr>
<th>Chapter Contents</th>
<th>Page</th>
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</thead>
<tbody>
<tr>
<td>Getting Started: Graphing a Circle</td>
<td>4-2</td>
</tr>
<tr>
<td>Defining a Graph</td>
<td>4-3</td>
</tr>
<tr>
<td>Setting Graph Modes</td>
<td>4-4</td>
</tr>
<tr>
<td>Defining Functions in the Y= List</td>
<td>4-5</td>
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<tr>
<td>Evaluating Y= Functions in Expressions</td>
<td>4-7</td>
</tr>
<tr>
<td>Selecting Functions</td>
<td>4-8</td>
</tr>
<tr>
<td>Defining the Viewing Window</td>
<td>4-9</td>
</tr>
<tr>
<td>Displaying a Graph</td>
<td>4-11</td>
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<tr>
<td>Exploring a Graph with the Free-Moving Cursor</td>
<td>4-12</td>
</tr>
<tr>
<td>Exploring a Graph with TRACE</td>
<td>4-13</td>
</tr>
<tr>
<td>Exploring a Graph with ZOOM</td>
<td>4-15</td>
</tr>
<tr>
<td>Setting the Zoom Factors</td>
<td>4-18</td>
</tr>
</tbody>
</table>
Getting Started: Graphing a Circle

Getting Started is a fast-paced introduction. Read the chapter for details.

Graph a circle of radius 10, centered on the origin in the standard viewing window. To graph a circle, you must enter separate formulas for the upper and lower portions of the circle. Then use ZSQUARE to adjust the display to make the functions appear as a circle.

Make sure that your TI-80 is in FUNC mode and all STAT PLOTS are turned off.

1. Press [Y=] to display the Y= edit screen. Press [2nd] [Y=] 100 [X]² + | [X]² [ENTER] to enter the expression \( Y_1=\sqrt{100-X^2} \), which defines the top half of the circle.

   The bottom half of the circle is defined by \( Y_2=-\sqrt{100-X^2} \). However, you can also define one function in terms of another; so to define \( Y_2=Y_1 \), press [2nd] [Y-VARS] (to display the Y= variables menu) 1 (to select Y1).

2. Press [ZOOM] 6 to select ZSTANDARD. This is a quick way to reset the Window variables to the standard values. It also graphs the functions; you do not need to press [GRAPH].

   Notice that the functions appear as an ellipse in the standard viewing window.

3. To adjust the display so each “dot” represents an equal width and height, press [ZOOM], and then 5 to select ZSQUARE. The functions are replotted and now appear as a circle on the display.

4. To see the ZSQUARE Window variables, press [WINDOW] and notice the values for XMIN, XMAX, YMIN, and YMAX.

5. If you want to see the graph again, press [GRAPH].

4-2 Function Graphing
Defining a Graph

To define a graph, you set the modes, enter and select the functions to graph, and define the viewing window and the graphing format. Once you have defined a graph, you can plot it, display it, and explore it.

Steps in Defining a Graph

There are six basic steps to defining a graph, although you may not need to do all of the steps each time you define a graph. The procedures are described in detail on the following pages.

1. Set the mode to **FUNC** graphing (Chapter 1).
2. Enter or edit a function in the **Y=** list (page 4-5).
3. Select the **Y=** function you want to graph (page 4-8).
4. Define the viewing window (page 4-9).
5. Set the graphing format (page 4-11).
6. Deselect **STAT PLOTS**, if appropriate (Chapter 9).

Exploring a Graph

Once you have defined a graph, you can display it and use several tools on the TI-80 to explore the behavior of the function or functions. These tools are described later in this chapter.
### Setting Graph Modes

Pressing `MODE` displays the current mode settings, as described in Chapter 1. For function graphing, the graphing mode must be set to `FUNC`. Before you graph a function, check to be sure that the mode settings are appropriate.

<table>
<thead>
<tr>
<th>Checking and Changing Graphing Modes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Press <code>MODE</code> to display the mode settings. The current settings are highlighted.</td>
<td></td>
</tr>
<tr>
<td>The TI-80 has two graphing modes.</td>
<td></td>
</tr>
<tr>
<td>• <strong>FUNC</strong> (function graphing)</td>
<td></td>
</tr>
<tr>
<td>• <strong>PARAM</strong> (parametric graphing)</td>
<td></td>
</tr>
<tr>
<td>To graph functions, you must select <strong>FUNC</strong> (function graphing).</td>
<td></td>
</tr>
<tr>
<td>The basics of graphing on the TI-80 are described in this chapter. Differences in parametric graphing are described in Chapter 5.</td>
<td></td>
</tr>
<tr>
<td>The mode settings can affect how functions are graphed.</td>
<td></td>
</tr>
<tr>
<td>• <strong>Radian</strong> or <strong>Degree</strong> mode may affect how some functions are interpreted.</td>
<td></td>
</tr>
<tr>
<td>• <strong>Connected</strong> or <strong>Dot</strong> affects how the selected functions are plotted.</td>
<td></td>
</tr>
<tr>
<td>• <strong>Sequential</strong> or <strong>Simul</strong> affects how functions are plotted if you have more than one function selected.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Setting Modes from a Program</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>You can set the graphing mode and other modes from a program.</td>
<td></td>
</tr>
<tr>
<td>Begin on a blank line in the program editor. Press <code>MODE</code> to display the <strong>Mode</strong> screen. Press and to place the cursor on the mode that you want to select, and then press <code>ENTER</code>. The name of the mode is copied to the cursor location.</td>
<td></td>
</tr>
</tbody>
</table>
Defining Functions in the Y= List

Pressing \( \text{Y=} \) displays the Y= edit screen. This is where you enter the functions to graph. You can store up to four functions in memory at one time. You can graph one or more of these functions at a time.

Displaying the Functions in the Y= List

Press \( \text{Y=} \) to display the Y= edit screen. In the example below, the \( Y_1 \) and \( Y_2 \) functions are defined.

Defining a New Function

To define a new function in the \( Y= \) list:

1. Press \( \text{Y=} \) to display the Y= edit screen.
2. Move the cursor to the function in the \( Y= \) list you want to define. If necessary, press \( \text{CLEAR} \) to erase a previously entered function.
3. Enter the expression to define the function.
   - You may use functions and variables in the expression. If the expression evaluates to a value that is not a real number, that point is not plotted; an error does not occur.
   - The independent variable in the function is \( X \). You may press \( X \) \( \text{TI} \), rather than pressing \( \text{ALPHA} \) \( X \), to enter the \( X \) variable. (\( \text{FUNC} \) mode defines the independent variable as \( X \).
   - The expression is stored as one of the four user-defined functions in the \( Y= \) list as you enter it.

Note: You can use a list within a \( Y= \) function; however, the function must evaluate to a single value.

4. When you complete the expression, press \( \text{ENTER} \) to move to the beginning of the next function.

Note: When you enter a function, it is automatically selected for graphing in the \( Y= \) list. This is indicated by the highlighted equal sign. For details on selecting and deselecting functions, see page 4-8.
To edit a function in the Y= list:
1. Press \( \boxed{\text{Y=}} \) to display the Y= list, and move the cursor to the function you want to change.
2. Make the changes. You can also press \( \boxed{\text{CLEAR}} \) to erase the expression, and then enter a new expression.

The expression is stored in the Y= list and selected (turned on) as you edit it.

To clear or erase a function on the Y= edit screen, position the cursor anywhere on the function, and then press \( \boxed{\text{M}} \).

To define a function from the Home screen or from a program, begin on a blank line.
1. Press \( \boxed{\text{[ALPHA]} \text{["]} \), enter the expression, and then press \( \boxed{\text{[ALPHA]} \text{["]} \) again.
2. Press \( \boxed{\text{STO}} \).
3. Press \( \boxed{2 \text{G}} \text{[Y-VARS]} \), and then select the name of the function from the Y menu. The name is copied to the cursor location.
4. Press \( \boxed{\text{ENTER}} \) to complete the instruction.

"expression"\( \rightarrow \boxed{Y_n} \)

When the instruction is executed, the TI-80 stores the expression in the Y= list, selects (turns on) the function, and displays the message \( \text{DONE} \).

To leave the Y= edit screen:
- Select another screen by pressing the appropriate key, such as \( \boxed{\text{GRAPH}} \) or \( \boxed{\text{WINDOW}} \).
- Press \( \boxed{2 \text{G}} \text{[QUIT]} \) to return to the Home screen.
Evaluating Y= Functions in Expressions

You can calculate the value of a Y= function at a specified value of X.

### Entering the Functions in the Y= List

To display the Y= list, press [Y]. Enter these functions for Y1, Y2, and Y3: \( X^2 \), \( X+2 \), and \( Y_1(Y_2(X)) \).

1. \( X \) \( \text{ENTER} \)
2. \( X \) \( 2 \) \( \text{ENTER} \)
3. \( \text{Y-VARS} \) \( 1 \) \( \text{ENTER} \)
4. \( \text{Y-VARS} \) \( 2 \) \( \text{ENTER} \)
5. \( \text{Y-VARS} \) \( 2 \) \( \text{ENTER} \)

### Evaluating Functions

To evaluate the functions, first specify the value of X. Note that X may be a list.

1. \( \text{2nd} \) \( \text{QUIT} \) \( \text{2nd} \) \( \text{Y-VARS} \) \( 2 \) \( \text{ENTER} \)
2. \( \text{2nd} \) \( \text{Y-VARS} \) \( 1 \) \( \text{Y-VARS} \) \( 2 \) \( \text{ENTER} \)
3. \( \text{2nd} \) \( \text{Y-VARS} \) \( 3 \) \( \text{ENTER} \)
4. \( \text{2nd} \) \( \text{Y-VARS} \) \( 1 \) \( \text{Y-VARS} \) \( 2 \) \( \text{ENTER} \)
5. \( \text{2nd} \) \( \text{Y-VARS} \) \( 3 \) \( \text{ENTER} \)

### Evaluating Functions without Parentheses

You can also evaluate functions without using parentheses by storing a value to X.

1. \( 3 \) \( \text{STO} \) \( \text{Y-VARS} \) \( 1 \) \( \text{ENTER} \)
2. \( \text{Y-VARS} \) \( 3 \) \( \text{ENTER} \)
3. \( \text{Y-VARS} \) \( 1 \) \( \text{ENTER} \)

---

Function Graphing 4-7
Selecting Functions

Only functions that are selected (turned on) are graphed. All four functions may be selected at one time.

Turning a Function “On” or “Off”

You can select and deselect ("turn on" and "turn off") functions on the \( Y = \) edit screen. The \( = \) sign on a selected function is highlighted.

To change the selection status of a function:

1. Display the \( Y = \) list, and move the cursor to the function whose status you want to change.
2. Press \( \text{6} \) to place the cursor over the \( = \) sign of the function.
3. Press \( \text{ENTER} \) to change the status. If the function was selected, it is now deselected. If it was deselected, it is now selected.

Note: When you enter or edit a function, it is selected automatically. When you clear a function, it is deselected.

Selecting Functions from the Home Screen or a Program

To select functions from the Home screen or a program, begin on a blank line.

1. Press \( \text{2nd} \) \( \text{[Y-VARS]} \), and then press \( \text{6} \) to select \text{ON/OFF}. The \text{ON/OFF} menu is displayed.
2. Select the instruction you want, \text{FNON} or \text{FNOFF}. It is copied to the cursor location.
3. To turn specific functions on or off, enter the number(s) of the function(s), separated by commas.

\text{FNON} \text{function#}, \text{function#}, \ldots
\text{FNOFF} \text{function#}, \text{function#}, \ldots

For example, in \text{FUNC} mode, \text{FNOFF 1,3} turns off functions \text{Y1} and \text{Y3}.

\[ \text{FNOFF 1,3} \]
The Window variables determine the boundaries and other attributes of the viewing window. The Window variables are shared by all graphing modes.

**The Viewing Window**

The viewing window of the TI-80 is the portion of the coordinate plane defined by $X_{\text{MIN}}$, $X_{\text{MAX}}$, $Y_{\text{MIN}}$, and $Y_{\text{MAX}}$. The distance between tick marks is defined by $X_{\text{SCL}}$ for the $X$ axis and $Y_{\text{SCL}}$ for the $Y$ axis.

**Checking the Viewing Window**

Press `WINDOW` to display the current Window variable values. The values shown here are the default values.

**Changing a Window Variable Value**

To change a Window variable value:

1. Press $\to$ to move to the Window variable you want to change.

2. To enter a real value (which can be an expression), you may do any of the following:
   - Position the cursor, and then make the changes.
   - Press `CLEAR` to clear the value, and then enter a new value.
   - Begin entering a new value. The original value is cleared automatically when you begin typing.

3. Press `ENTER`, $\to$, or $\to$. If you entered an expression, it is evaluated. The new value is stored.

$X_{\text{MIN}}$ must be less than $X_{\text{MAX}}$, and $Y_{\text{MIN}}$ must be less than $Y_{\text{MAX}}$, or you will get an error message when you press `GRAPH`. To turn off the tick marks, set $X_{\text{SCL}}=0$ and $Y_{\text{SCL}}=0$. 
To leave the Window screen:

- Select another screen by pressing the appropriate key, such as [GRAPH] or [Y=].
- Press [QUIT] to return to the Home screen.

To store to a Window variable from the Home screen or from a program, begin on a blank line.

1. Enter the value (which can be an expression) that you want to store.
2. Press [STO→].
3. Press [VARS] to display the VARS menu.
4. Select WINDOW... to display the Window variables.
5. Select the Window variable. The name of the variable is copied to the cursor location.
6. Press [ENTER] to complete the instruction.

Note: You can use a Window variable in an expression by performing steps 3, 4, and 5.

ΔX and ΔY

The variables ΔX and ΔY define the distance between the centers of two adjoining pixels on a graph (graphing accuracy).

\[ \Delta X = \frac{(X_{\text{MAX}} - X_{\text{MIN}})}{62} \quad \Delta Y = \frac{(Y_{\text{MAX}} - Y_{\text{MIN}})}{46} \]

ΔX and ΔY are not on the Window screen; however, they are accessible through the VARS WINDOW... menu. ΔX and ΔY are calculated from XMIN, XMAX, YMIN, and YMAX when a graph is displayed.

You can store values directly to ΔX and ΔY (7 and 8 on the VARS WINDOW... menu), in which case XMAX and YMAX are immediately calculated from ΔX, XMIN, ΔY, and YMIN.
Displaying a Graph

Pressing [GRAPH] graphs any functions selected on the Y= edit screen. The current mode settings apply, and the current values of the Window variables define the viewing window.

Grid points correspond to the axis tick marks. To turn the grid points on and off use GRIDON and GRIDOFF. The default for the TI-80 is GRIDOFF.

1. From the Home screen, press 2nd [DRAW] to display the DRAW menu.
2. Press 9 to select GRIDON, or press 0 to select GRIDOFF.
3. Press [ENTER]. The message DONE is displayed.

Pressing [GRAPH] to display the graph of the selected function or functions. (Some operations, such as TRACE and the Zoom instructions, display the graph automatically.) As a graph is plotted, the busy indicator is on, and X and Y are updated.

When you press [GRAPH], Smart Graph displays the graph screen immediately if nothing has changed that requires the functions to be replotted since the last time the graph was displayed.

If you have changed any of the following since the graph was last displayed, pressing [GRAPH] replots the graph based on the new values.

- Changed a mode setting that affects graphs.
- Changed a function in the current picture.
- Deselected a function in the current picture.
- Changed the value of a variable in a selected function.
- Changed a Window variable or format setting.
- Cleared drawings by selecting CLRDRW (Chapter 7).
- Changed or turned off a STAT PLOT definition (Chapter 9).

Note: CLRDRW is a fast way to replot a graph.

The TI-80 lets you graph one function at a time without reploting every function. For example, enter SIN X as Y1 and press [GRAPH]. Then enter COS X as Y2 and press [GRAPH] again. The second function is graphed on top of the original function.
Exploring a Graph with the Free-Moving Cursor

While a graph is displayed, you can move the free-moving cursor anywhere on the graph and display the coordinates of any location on the graph.

Free-Moving Cursor

You can press \( \leftarrow \), \( \rightarrow \), \( \downarrow \), or \( \uparrow \) to move the cursor around the graph. When you first display the graph, no cursor is visible. As soon as you press \( \leftarrow \), \( \rightarrow \), \( \downarrow \), or \( \uparrow \), the cursor moves from the center of the viewing window.

As you move the cursor around the graph, the values of the variables \( X \) and \( Y \) are updated, and the coordinate values of the cursor location are displayed at the bottom of the screen. Coordinate values generally appear in floating-decimal format. The numeric display settings on the MODE screen do not affect coordinate display.

To see the graph without the cursor or coordinate values, press \( \text{GRAPH} \) or \( \text{CLEAR} \). When you press \( \leftarrow \), \( \rightarrow \), \( \downarrow \), or \( \uparrow \), the cursor begins to move from the same position.

Graphing Accuracy

The free-moving cursor moves from dot to dot on the screen. When you move the cursor to a dot that appears to be “on” the function, it may be near, but not on, the function; therefore, the coordinate value displayed at the bottom of the screen is not necessarily a point on the function. To move the cursor along a function, use \( \text{TRACE} \) (page 4-13).

The displayed coordinate values of the free-moving cursor approximate actual math coordinates accurate to within the width/height of the dot. As \( X_{\text{MIN}} \) and \( X_{\text{MAX}} \) (and \( Y_{\text{MIN}} \) and \( Y_{\text{MAX}} \)) get closer together (after a \( \text{ZOOM IN} \), for example), graphing accuracy increases, and the coordinate values more closely represent the math coordinates.

![Free-moving cursor “on” the curve](image)

4-12  Function Graphing
Exploring a Graph with TRACE

TRACE moves the cursor from one plotted point to the next along a function. The cursor coordinates are displayed at the bottom of the screen.

**Beginning a Trace**

Press \[ \text{TRACE} \] to begin a trace. If the graph is not displayed already, the TI-80 displays it. The cursor is on the first selected function in the \( Y= \) list at the middle \( X \) value on the screen. The number of the function appears at the upper right of the display.

**Note:** If any STAT PLOTS are turned on, the TI-80 attempts to trace the first stat plot.

**Moving along a Function**

Press \[ \leftarrow \] and \[ \rightarrow \] to move the cursor along the function. Each press moves the cursor from one plotted point to the next.

Press \[ \downarrow \leftarrow \] and \[ \uparrow \rightarrow \] to move the cursor five plotted points at a time. Tracing updates and displays the values of the variables \( X \) and \( Y \). The \( Y \) value is calculated from the \( X \) value; that is, \( Y = Y_n(X) \). If the function is undefined at an \( X \) value, the \( Y \) value is blank.

If the \( Y \) value of a function is above or below the viewing window, the cursor disappears as you move it to that portion of the function. However, the coordinate values at the bottom of the screen indicate the cursor coordinates.

**Panning to the Left or Right**

If you trace a function off the left or right edge of the screen, the viewing window automatically pans to the right or left. \( \text{XMIN} \) and \( \text{XMAX} \) are updated to correspond to the new viewing window.

**Note:** The screen does not pan if a STAT PLOT is on.

**QuickZoom**

While tracing, you can press \[ \text{ENTER} \] to adjust the viewing window so that the cursor location becomes the center of a new viewing window, even if the cursor is above or below the display. This allows “panning” up and down. After QuickZoom, TRACE is still active.
To trace another selected function on the graph, press \( \text{ or } \) to move the cursor to that function. The cursor moves to the new function at the same \( X \) value. The function number in the upper right corner of the display changes.

The cursor movement is based on the order of the selected functions in the \( Y= \) list, not the appearance of the functions as graphed on the screen.

**Leaving TRACE**

To leave **TRACE**:

- Select another screen by pressing the appropriate key, such as **WINDOW** or **ZOOM**.
- Press **GRAPH** or **CLEAR** to see the graph without the Trace cursor.
- Press \( 2 \text{nd} \) [QUIT] to return to the Home screen.

The Trace cursor remains in the same location if you leave **TRACE** and return, as long as Smart Graph has not caused the graph to be replotted.

**Using TRACE in a Program**

On a blank line in the program editor, press **TRACE**. The instruction **Trace** is copied to the cursor location. When the instruction is encountered during program execution, the graph is displayed with the Trace cursor on the first selected function. As you trace, the cursor coordinate values are updated. When you finish tracing the function(s), press **ENTER** to resume program execution.
Exploring a Graph with ZOOM

Pressing [ZOOM] displays a menu that allows you to adjust the viewing window of the graph quickly in a variety of ways. All of the Zoom instructions are accessible from programs.

### ZOOM Menu

<table>
<thead>
<tr>
<th>ZOOM</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:ZBOX</td>
<td>Draws box to define viewing window.</td>
</tr>
<tr>
<td>2:ZOOM IN</td>
<td>Magnifies graph around cursor.</td>
</tr>
<tr>
<td>3:ZOOM OUT</td>
<td>Views more of graph around cursor.</td>
</tr>
<tr>
<td>4:ZDECSIMAL</td>
<td>Sets .1 as dot size.</td>
</tr>
<tr>
<td>5:ZSQUARE</td>
<td>Sets equal sized-dots on X and Y axes.</td>
</tr>
<tr>
<td>6:ZSTANDARD</td>
<td>Sets standard Window variables.</td>
</tr>
<tr>
<td>7:ZTRIG</td>
<td>Sets built-in trig Window variables.</td>
</tr>
</tbody>
</table>

**ZBOX** lets you use the cursor to select opposite corners of a box to define a new viewing window.

1. Select [ZBOX] from the [ZOOM] menu. The different cursor at the center of the screen indicates that you are using a Zoom instruction.

2. Move the cursor to any corner of the box you want to define, and then press [ENTER]. As you move the cursor away from the point just selected, you see a small square dot, indicating that the first corner is selected.

3. Move the cursor to the diagonal corner of the box you want to define. As you move the cursor, the boundaries of the box change on the screen.

   **Note:** Before you press [ENTER], you can cancel [ZBOX] at any time by pressing [CLEAR].

4. When the box is defined as you want it, press [ENTER] to replot the graph.

You can repeat steps 2 through 4 to do another [ZBOX].
**ZOOM IN** magnifies the graph around the cursor location. The \textit{XFACT} and \textit{YFACT} settings determine the extent of the zoom (page 4-18). The default value for both \textit{XFACT} and \textit{YFACT} is 4.

1. After checking or changing \textit{XFACT} and \textit{YFACT}, select \textit{ZOOM IN} from the \textit{ZOOM} menu.

   Notice the different cursor. It indicates that you are using a Zoom instruction.

2. Move the cursor to the point that you want as the center of the new viewing window, and then press [ENTER].

   The TI-80 adjusts the viewing window by \textit{XFACT} and \textit{YFACT}, updates the Window variables, and replots the selected functions centered on the cursor location.

3. \textit{ZOOM IN} is still turned on. To zoom in on the graph again:
   
   • At the same point, press [ENTER].
   
   • At a new point, move the cursor to the point that you want as the center of the new viewing window, and then press [ENTER].

**ZOOM OUT** displays a greater portion of the graph, centered on the cursor location, to provide a more global view. The procedure for \textit{ZOOM OUT} is the same as for \textit{ZOOM IN}.

**Leaving ZOOM IN or ZOOM OUT**

To leave \textit{ZOOM IN} or \textit{ZOOM OUT}:

• Select another screen by pressing the appropriate key, such as [TRACE] or [GRAPH].

• Press [2nd] [QUIT] to return to the Home screen.
ZDECIMAL  

ZDECIMAL replots the functions immediately, updates the Window variables to preset values that set $\Delta X$ and $\Delta Y$ equal to .1, and defines the $X$ and $Y$ value of each pixel as one decimal.

$$X_{MIN} = -3.1 \quad Y_{MIN} = -2.3$$
$$X_{MAX} = 3.1 \quad Y_{MAX} = 2.3$$
$$X_{SCL} = 1 \quad Y_{SCL} = 1$$

ZSQUARE  

ZSQUARE replots the functions immediately, redefining the window based on the current Window variables, but adjusted in only one direction so that $\Delta X = \Delta Y$. This makes the graph of a circle look like a circle. $X_{SCL}$ and $Y_{SCL}$ remain unchanged. The midpoint of the current graph (not the intersection of the axes) becomes the midpoint of the new graph.

ZSTANDARD  

ZSTANDARD replots the functions immediately, updating the Window variables to the standard values:

$$X_{MIN} = -10 \quad Y_{MIN} = -10$$
$$X_{MAX} = 10 \quad Y_{MAX} = 10$$
$$X_{SCL} = 1 \quad Y_{SCL} = 1$$

ZTRIG  

ZTRIG replots the functions immediately, updating the Window variables to preset values appropriate for plotting trig functions. In Radian mode, these are:

$$X_{MIN} = (-\frac{31}{12})\pi \cdot (\approx 8.115781..) \quad Y_{MIN} = -2 \cdot (\approx 2)$$
$$X_{MAX} = (\frac{31}{12})\pi \cdot (\approx 8.1157810..) \quad Y_{MAX} = 2 \cdot (\approx 2)$$
$$X_{SCL} = (\pi/2) \cdot (\approx 1.5707963..) \quad Y_{SCL} = 1 \cdot (\approx 1)$$
Setting the Zoom Factors

The Zoom factors, XFACT and YFACT, determine the extent of the change for the viewing window created by ZOOM IN or ZOOM OUT on a graph.

**Zoom Factors**

Zoom factors are positive numbers (not necessarily integers) greater than or equal to 1. They define the magnification or reduction factor used to ZOOM IN or ZOOM OUT around a point.

**Checking Zoom Factors**

To review the current values of the Zoom factors (XFACT and YFACT):

1. Press 
2. Press 9 to select XFACT or 0 to select YFACT. XFACT or YFACT is copied to the cursor location.
3. Press . The Zoom factor is displayed.

\[
\begin{align*}
3 \rightarrow & XFACT \\
3 \rightarrow & YFACT
\end{align*}
\]

**Setting Zoom Factors from the Home Screen or a Program**

To set the Zoom factors XFACT and YFACT from the Home screen or a program, begin on a blank line.

1. Enter the factor, and then press .
2. Press , and then press 1 to select WINDOW....
3. Press 9 to select XFACT or 0 to select YFACT. XFACT or YFACT is copied to the cursor location on the Home screen.
4. Press to store the Zoom factor to the variable.

\[
\begin{align*}
\text{XFACT} & \rightarrow 4 \\
2 \rightarrow & XFACT
\end{align*}
\]

4-18  Function Graphing
Chapter 5: Parametric Graphing

This chapter describes how to graph parametric equations on the TI-80. Before doing parametric graphing, you should be familiar with Chapter 4, Function Graphing.

<table>
<thead>
<tr>
<th>Chapter Contents</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Getting Started: Path of a Ball</td>
<td>5-2</td>
</tr>
<tr>
<td>Defining and Displaying a Parametric Graph</td>
<td>5-3</td>
</tr>
<tr>
<td>Exploring a Parametric Graph</td>
<td>5-6</td>
</tr>
</tbody>
</table>
Getting Started is a fast-paced introduction. Read the chapter for details.

Graph the parametric equation that describes the path of a ball kicked at an angle of 60° with an initial velocity of 15 meters per second. (Ignore air resistance.) What is the maximum height? When does the ball strike the ground?

1. Press \( \text{MODE} \), and then press \( \boxed{8} \) \( \boxed{8} \) \( \boxed{8} \) \( \boxed{9} \) to select \( \text{PARAM} \) mode.

   For initial velocity \( v_0 \) and angle \( \theta \), the horizontal component of the ball as a function of time is \( X(t) = t v_0 \cos \theta \). The vertical component is \( Y(t) = t v_0 \sin \theta - \frac{g}{2} t^2 \). The gravity constant \( g \) is 9.8 m/sec\(^2\).

2. Press \( \boxed{Y} \). Press \( 15 \boxed{X} \boxed{1} \boxed{\cos} \boxed{60} \boxed{\theta} \boxed{\angle} \boxed{1} \) (to select \( \theta \)) \( \boxed{\text{ENTER}} \) to define the \( X \) portion of the parametric equation in terms of \( T \).

3. Press \( 15 \boxed{X} \boxed{1} \boxed{\sin} \boxed{60} \boxed{\theta} \boxed{\angle} \boxed{1} \) (to select \( \theta \)) \( \boxed{\text{ENTER}} \) to define the \( Y \) portion.

4. Press \( \boxed{\text{WINDOW}} \). Enter the Window variables appropriate for this problem.
   
   \[
   \begin{align*}
   \text{TMIN} &= 0 & \text{XMIN} &= -2 & \text{YMIN} &= -2 \\
   \text{TMAX} &= 3 & \text{XMAX} &= 25 & \text{YMAX} &= 10 \\
   \text{TSTEP} &= 0.2 & \text{XSCL} &= 5 & \text{YSCL} &= 5
   \end{align*}
   \]

5. Press \( \boxed{\text{TRACE}} \) to graph the position of the ball as a function of time.

   Tracing begins at \( \text{TMIN} \). As you press \( \boxed{\uparrow} \) to trace the curve, the cursor follows the path of the ball over time. The values for \( X \) (distance), \( Y \) (height), and \( T \) (time) are displayed at the bottom of the screen.

   The maximum height is approximately 8.6 meters. The ball strikes the ground in approximately 2.6 seconds.
### Defining and Displaying a Parametric Graph

Parametric equations consist of an X component and a Y component, each expressed in terms of the same independent variable T. They are often used to graph equations over time. Up to three pairs of parametric equations can be defined and graphed at a time.

<table>
<thead>
<tr>
<th>Defining a Parametric Graph</th>
<th>The steps for defining a parametric graph are the same as those for defining a function graph (page 4-3). Differences are noted below.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting Parametric Graph Modes</td>
<td>Press MODE to display the mode settings. To graph parametric equations, you must select PARAM before you enter Window variables or enter the components of parametric equations. Normally, you should also select CONNECTED to obtain a more meaningful parametric graph.</td>
</tr>
<tr>
<td>Displaying Parametric Equations</td>
<td>After selecting PARAM mode, press ( \text{\textsc{Y=}} ) to display the parametric Y= edit screen.</td>
</tr>
<tr>
<td>On this screen, you display and enter both the X and Y components. The TI-80 allows three parametric equations, each defined in terms of T.</td>
<td></td>
</tr>
<tr>
<td>Defining Parametric Equations</td>
<td>Follow the same procedures as for function graphing (pages 4-5 to 4-6) to enter the two components that define a new parametric equation.</td>
</tr>
<tr>
<td>- You must define both the X and Y components in a pair.</td>
<td></td>
</tr>
<tr>
<td>- The independent variable in each component is T. You may press ( \text{\textsc{X,T}} ), rather than pressing ( \text{\textsc{ALPHA T}} ), to enter the parametric variable T. (PARAM mode defines the independent variable as T.)</td>
<td></td>
</tr>
</tbody>
</table>
### Selecting Parametric Equations

The TI-80 graphs only the parametric equations you select. The highlighted = sign on both components of an equation indicates that the equation is selected.

You may select any or all of the equations on the parametric Y= edit screen.

To change the selection status of a parametric equation, press 6 to move the cursor onto the = sign of either the X or Y component and press [ENTER]. The status on both the X and Y components changes.

**Note:** When you enter both components of an equation or edit either component, that equation is selected automatically.

### Setting Window Variables

Press [WINDOW] to display the current Window variable values. The Window variables define the viewing window. The values shown are the standard values in **Radian** mode.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMIN</td>
<td>0</td>
<td>Smallest T value to evaluate.</td>
</tr>
<tr>
<td>TMAX</td>
<td>6.283185307</td>
<td>Largest T value to evaluate.</td>
</tr>
<tr>
<td>TSTEP</td>
<td>0.1308996938996</td>
<td>T value increment.</td>
</tr>
<tr>
<td>XMIN</td>
<td>-10</td>
<td>Smallest X value to be displayed.</td>
</tr>
<tr>
<td>XMAX</td>
<td>10</td>
<td>Largest X value to be displayed.</td>
</tr>
<tr>
<td>XSCL</td>
<td>1</td>
<td>Spacing between X tick marks.</td>
</tr>
<tr>
<td>YMIN</td>
<td>-10</td>
<td>Smallest Y value to be displayed.</td>
</tr>
<tr>
<td>YMAX</td>
<td>10</td>
<td>Largest Y value to be displayed.</td>
</tr>
<tr>
<td>YSCL</td>
<td>1</td>
<td>Spacing between Y tick marks.</td>
</tr>
</tbody>
</table>

To change a Window variable value, follow the steps given for function graphing (page 4-8).

**Note:** You may want to change the T variable values to ensure that sufficient points are plotted.
When you press `[GRAPH]`, the TI-80 plots the selected parametric equations. It evaluates both the $X$ and the $Y$ component for each value of $T$ (from $T_{\text{MIN}}$ to $T_{\text{MAX}}$ in intervals of $T_{\text{STEP}}$) and then plots each point defined by $X$ and $Y$. The Window variables define the viewing window.

As a graph is plotted, the TI-80 updates $X$, $Y$, and $T$.

**Note:** Smart Graph applies to parametric graphs also (page 4-11).

By means of the VARS WINDOW... and Y-VARS menus, you can:

- Access functions by using the name of the component of the equation as a variable.
- Select or deselect parametric equations from a program, using the FNON and FNOFF commands (page 4-8).
- Store parametric equations.
- Store values directly to Window variables.
Exploring a Parametric Graph

As in function graphing, three tools are available for exploring a graph: the free-moving cursor, tracing, and zooming.

<table>
<thead>
<tr>
<th>Free-Moving Cursor</th>
<th>The free-moving cursor works the same in parametric graphing as in function graphing (page 4-12).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tracing a Parametric Graph</td>
<td>Pressing [TRACE] puts the Trace cursor on the first selected equation, at TMIN. You can then trace along the equation.</td>
</tr>
<tr>
<td><strong>1</strong> or [+]</td>
<td>Moves the cursor one TSTEP at a time.</td>
</tr>
<tr>
<td>[2nd] [1] or [+]</td>
<td>Moves the cursor five TSTEPs at a time.</td>
</tr>
<tr>
<td>[◄] or [ ► ]</td>
<td>Changes to the previous or next equation. The equation number shows in the upper right of the display.</td>
</tr>
<tr>
<td>CLEAR</td>
<td>Cancels tracing.</td>
</tr>
</tbody>
</table>

For each value of T, the calculator displays values for X and Y.

The values for X, Y, and T are updated as you move the Trace cursor. If the cursor moves off the top or bottom of the screen, the coordinate values continue to change appropriately.

The Trace cursor remains in the same location if you leave TRACE and return, unless Smart Graph replots the graph.

QuickZoom is available in parametric graphing, but panning is not (page 4-13).

<table>
<thead>
<tr>
<th>Zooming in on a Parametric Graph</th>
<th>Pressing [ZOOM] works the same in parametric graphing as in function graphing (page 4-15).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parametric graphing uses the additional Window variables TMIN, TMAX, and TSTEP. These variables are not affected by zooming unless you select ZSTANDARD, where TMIN = 0, TMAX = 6.283185307 (2π), and TSTEP = .130899693896 (π/24).</td>
<td></td>
</tr>
</tbody>
</table>

5-6 Parametric Graphing
Chapter 6: Tables

This chapter describes how to use tables on the TI-80. A table evaluates the selected functions from the Y= list and displays each value for the independent variable along with the evaluated value for each corresponding dependent variable.

<table>
<thead>
<tr>
<th>Chapter Contents</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Getting Started: Roots of a Function</td>
<td>6-2</td>
</tr>
<tr>
<td>Defining the Independent Variable</td>
<td>6-3</td>
</tr>
<tr>
<td>Defining the Dependent Variable</td>
<td>6-4</td>
</tr>
<tr>
<td>Displaying the Table</td>
<td>6-5</td>
</tr>
</tbody>
</table>
getting started: roots of a function

getting started is a fast-paced introduction. read the chapter for details.

evaluate the function \( y = x^2 - 4x + 3 \) at each integer between \(-10\) and \(10\). how many sign changes are there, and where do they occur?

1. If necessary, select \textbf{func} from the \textbf{mode} menu. Press \( \text{on} \ [\text{tble set} \) to display the \textbf{table setup} screen. Press \( \varnothing \ 10 \) to set \( \text{tblmin} = 10 \). Leave \( \Delta \text{tbl} = 1 \).

2. Press \( \varnothing \ \varnothing \ \varnothing \ 4 \ \varnothing \ \varnothing \ 3 \) to enter the function \( y_1 = x^2 - 4x + 3 \).

3. Press \( \text{on} \ \text{table} \) to display the table screen.

4. Press \( \varnothing \) repeatedly to view the changes in the value of \( y_1 \).

6-2 tables
Defining the Independent Variable

The independent variable for a table is the independent variable in the current graphing mode (X for FUNC mode and T for PARAM mode). You define the minimum value and the incremental value for the independent variable on the TABLE SETUP screen.

**TABLE SETUP Screen**

To display the **TABLE SETUP** screen, press 2nd [TBLSET]. The default values are shown below.

```
TABLE SETUP
TBLMIN=8
@TBL=1
```

**TBLMIN and @TBL**

**TBLMIN** (table minimum) defines the initial value for the independent variable: X (FUNC mode) or T (PARAM mode).

**@TBL** (table step) defines the increment for the independent variable.

To change **TBLMIN** and **@TBL**, simply enter the values at the blinking cursor. To move between **TBLMIN** and **@TBL**, press 8 and 7.

You can also store values to **TBLMIN** and **@TBL** from the Home screen or a program. The variable names are on the **VARS TABLE...** menu.

To change **TBLMIN** or **@TBL** from the Home screen or a program, begin on a blank line.

1. Enter the value for **TBLMIN** or **@TBL**.
2. Press 2nd [STO].
3. Press [VAR] to display the **VARS** menu.
4. Press 3 to select **TABLE...**.
5. Select the table variable (**TBLMIN** or **@TBL**). The name of the variable is copied to the cursor location.
6. Press [ENTER] to store the value for the table variable.

```
10→TBLMIN
1→@TBL
```
### Defining the Dependent Variable

The selected functions from the Y= list define the dependent variables. You can have as many dependent variables as there are functions in the current graphing mode (four for FUNC mode and six for PARAM mode).

#### From the Y= Editor

Enter the functions to define the dependent variables in the Y= editor.

<table>
<thead>
<tr>
<th>FUNC Mode</th>
<th>PARAM Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Y_1 = x^2 + 2$</td>
<td>$X_1 = \cos 60^\circ$</td>
</tr>
<tr>
<td>$Y_2 = x$</td>
<td>$Y_1 = \sin 60^\circ - (x^2 + 2)^2$</td>
</tr>
<tr>
<td>$Y_3 = x^n$</td>
<td>$X_2 =$</td>
</tr>
<tr>
<td>$Y_4 =$</td>
<td>$X_3 =$</td>
</tr>
</tbody>
</table>

In **PARAM** mode, you must define both components of the parametric equation (Chapter 5).

Only functions that are selected are displayed in the table. (When $=$ is highlighted, the function is selected.) You can select and deselect functions from the Y= list, from the Home screen, or from a program. (Refer to page 4-8 for information on selecting and deselecting.)
Displaying the Table

The table displays up to six values for the independent variable, along with the six corresponding values of one dependent variable, at a time. Once the table is displayed, you can press 4, 5, 7, and 8 to move around and scroll the table, displaying other independent and dependent values.

The Table

Press [MODE] [TABLE] to display the table screen.

<table>
<thead>
<tr>
<th>FUNC Mode</th>
<th>PARAM Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>X=0</td>
<td>T=0</td>
</tr>
</tbody>
</table>

The top line displays the name of the independent variable (X for FUNC mode; T for PARAM mode) and one dependent variable (Yn for FUNC mode; XnT or YnT for PARAM mode). The bottom line displays the full value of the current cell, which is indicated by the rectangular cursor. The center portion is used to display the values of the variables, abbreviated to six digits if necessary.

Displaying More Independent Values

Press ▲ and ▼ to display additional values for the independent variable and the values for one corresponding dependent variable.

Note: You can scroll “back” from the value entered for TBLMIN. As you scroll, TBLMIN is updated automatically to the value shown on the top line of the table. In the example below, TBLMIN=0, △TBL=1, and Y1=X^2+2 generates and displays values of X=0, . . . , 5. You can press ▼ to scroll backward and display the table for X=1, . . . , 4.

<table>
<thead>
<tr>
<th>FUNC Mode</th>
<th>PARAM Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>X=0</td>
<td>T=0</td>
</tr>
</tbody>
</table>

Tables 6-5
If you have more than one function defined and selected, press $9$ to display other dependent variables. In the example below, $\text{TBLMIN}=0$, $\Delta \text{TBL}=1$, $Y_1=X^2+2$ and $Y_2=X^3-2$. You can press $9$ to see the values for $Y_2$. 

![Table Example]

6-6 Tables
Chapter 7: Draw Operations

This chapter describes how to use the DRAW operations of the TI-80. Before using the DRAW operations, you should be familiar with Chapter 4, Function Graphing.

<table>
<thead>
<tr>
<th>Chapter Contents</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Getting Started: Shading a Graph</td>
<td>7-2</td>
</tr>
<tr>
<td>DRAW DRAW Menu</td>
<td>7-3</td>
</tr>
<tr>
<td>Drawing Lines</td>
<td>7-4</td>
</tr>
<tr>
<td>Drawing Horizontal and Vertical Lines</td>
<td>7-5</td>
</tr>
<tr>
<td>Drawing a Function</td>
<td>7-6</td>
</tr>
<tr>
<td>Shading Areas on a Graph</td>
<td>7-7</td>
</tr>
<tr>
<td>Drawing Points</td>
<td>7-10</td>
</tr>
<tr>
<td>Clearing a Drawing</td>
<td>7-12</td>
</tr>
</tbody>
</table>
Getting Started: Shading a Graph

Getting Started is a fast-paced introduction. Read the chapter for details.

Shade the area below the function \( Y=X-2 \) and above the functions \( Y=X+1 \) and \( Y=-X \).

1. If necessary, select **FUNC** mode. Press \( \text{Y=} \) and enter the functions:

\[
Y_1= |X| - 2 \quad \text{ENTER}
Y_2= |X| + 1 \quad \text{ENTER}
Y_3= |X| \quad \text{ENTER}
\]

(Be sure that \( Y_4 \) is cleared or turned off.)

2. Press \( \text{ZOOM 4} \) to select the **ZDECEIMAL** viewing window, clear any existing drawings, and display the viewing window and graph.

3. Press \( \text{QUIT} \) to return to the Home screen.

4. Press \( \text{DRAW 7} \) to select **SHADE_Y<**, which is copied to the Home screen.

5. Press \( \text{Y-VARS 1} \) (to select \( Y_1 \)).

6. Press \( \text{:} \) to add another instruction to this line.

7. Press \( \text{DRAW 6} \) to select **SHADE_Y>**, which is copied to the Home screen.

8. Press \( \text{Y-VARS 2} \) (to select \( Y_2 \)) \( \text{DRAW 3} \) (to select \( Y_3 \)).

9. Press \( \text{ENTER} \) to see the functions and shading on the graph.

---

7-2 Draw Operations
**DRAW DRAW Menu**

To display the DRAW DRAW menu, press `2nd DRAW`. What happens when you select an item from this menu depends on whether or not a graph is displayed when you access the menu, as described under each operation.

<table>
<thead>
<tr>
<th>DRAW DRAW Menu</th>
<th>DRAW POINTS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1: CLRDRAW</td>
<td>Clears all drawn elements.</td>
<td></td>
</tr>
<tr>
<td>2: LINE(</td>
<td>Draws a line between two points.</td>
<td></td>
</tr>
<tr>
<td>3: HORIZONTAL</td>
<td>Draws a horizontal line.</td>
<td></td>
</tr>
<tr>
<td>4: VERTICAL</td>
<td>Draws a vertical line.</td>
<td></td>
</tr>
<tr>
<td>5: DRAWF</td>
<td>Draws a function.</td>
<td></td>
</tr>
<tr>
<td>6: SHADE_Y&gt;</td>
<td>Shades an area.</td>
<td></td>
</tr>
<tr>
<td>7: SHADE_Y&lt;</td>
<td>Shades an area.</td>
<td></td>
</tr>
<tr>
<td>8: SHADE(</td>
<td>Shades an area.</td>
<td></td>
</tr>
<tr>
<td>9: GRIDON</td>
<td>Turns the graph grid on.</td>
<td></td>
</tr>
<tr>
<td>0: GRIDOFF</td>
<td>Turns the graph grid off.</td>
<td></td>
</tr>
</tbody>
</table>

(See page 7-12 for an explanation of CLRDRAW.)

**Before Drawing on a Graph**

Because Draw operations draw on top of the graph of currently selected functions, you may want to do one or more of the following before drawing on a graph:

- Change the mode settings.
- Enter or edit functions in the \( Y= \) list.
- Select or deselect functions in the \( Y= \) list.
- Change Window variable values.
- Turn STAT PLOTS on or off.
- Clear existing drawings with CLRDRAW (page 7-12).

**Drawing on a Graph**

Draw operations can draw on FUNC and PARAM graphs. The coordinates for all Draw instructions are always the X-coordinate and Y-coordinate values of the display.

You can use most of the operations from the DRAW DRAW and DRAW POINTS menus to draw directly on a graph, using the cursor to identify coordinates; or you can execute these instructions from the Home screen or a program.
**Drawing Lines**

While a graph is displayed, LINE( lets you use the cursor to define a line on the graph. If a graph is not displayed, the instruction is copied to the Home screen.

### Directly on a Graph

To define a line directly on a graph:

1. When a graph is displayed, select LINE( from the DRAW DRAW menu (item 2).
2. Position the cursor at the beginning point of the line you want to draw. Press ENTER.
3. Move the cursor to the end point of the line you want to draw. The line is displayed as you move the cursor. Press ENTER.

To continue to draw lines, repeat steps 2 and 3. To cancel LINE(, press CLEAR.

### From the Home Screen or a Program

LINE( (DRAW DRAW, item 2) draws a line between the coordinates \((X1,Y1)\) and \((X2,Y2)\). The values may be entered as expressions.

LINE\((X1,Y1,X2,Y2)\)

For example, enter LINE\((0,0,6,9)\) on the Home screen, and then press ENTER.
### Drawing Horizontal and Vertical Lines

While a graph is displayed, HORIZONTAL and VERTICAL let you define lines on the graph using the cursor. If a graph is not displayed, the instruction is copied to the Home screen.

#### Directly on a Graph

To draw horizontal and vertical lines directly on a graph:

1. When a graph is displayed, select HORIZONTAL (item 3) or VERTICAL (item 4) from the DRAW DRAW menu.

2. A line is displayed that moves as you move the cursor. Position the cursor where you want to draw the line. Press Enter. The line is drawn on the graph.

![Graph with horizontal and vertical lines](image)

To continue to draw lines, repeat step 2. To cancel HORIZONTAL or VERTICAL, press CLEAR.

#### From the Home Screen or a Program

HORIZONTAL (DRAW DRAW, item 3) draws a horizontal line at $Y=Y$ (which can be an expression, but not a list).

**HORIZONTAL Y**

VERTICAL (DRAW DRAW, item 4) draws a vertical line at $X=X$ (which can be an expression, but not a list).

**VERTICAL X**

![Graph with horizontal and vertical lines](image)

**Note:** In the example above, the horizontal line is drawn first, and then the vertical line is drawn.
Drawing a Function

**DRAWF** (draw function) draws a function on the current graph. **DRAWF** must be entered on the Home screen or in the program editor.

**Drawing a Function**

**DRAWF** (draw function, **DRAW DRAW**, item 5) is not an interactive operation. It draws the specified expression as a function in terms of \( X \) on the current graph.

**DRAWF expression**

For example, if \( Y1=\frac{2X^3}{2X+6} \) is the only selected function, **DRAWF Y1–5** plots \( Y1 \) and then draws the function \( Y1–5 \) when you press [ENTER].

![Graph of function Y1–5]

**Note:** You cannot trace on **DRAWF** functions.

**Using GRIDON and GRIDOFF**

**GRIDON** (**DRAW DRAW**, item 9) and **GRIDOFF** (**DRAW DRAW**, item 0) set graphs to be drawn with the grid points on or off, respectively. The grid points correspond to the axes tick marks. The default for the TI-80 is **GRIDOFF**.

1. From the Home screen, press [2nd] [DRAW] to display the **DRAW** menu.
2. Press 9 to select **GRIDON**, or press 0 to select **GRIDOFF**.
3. Press [ENTER]. The message **DONE** is displayed. The next time the graph is displayed, the grid points will be on if you selected **GRIDON**, or off if you selected **GRIDOFF**.

![Grid on and Grid off]

7-6 Draw Operations
**Shading Areas on a Graph**

There are three shading instructions on the DRAW DRAW menu: SHADE₇>,Y, SHADE₇<, and SHADE(). These instructions are not interactive; they must be entered on the Home screen or in the program editor.

**Shading Areas above a Function**

SHADE₇> (DRAW DRAW, item 6) takes up to four arguments (functions of X).

```
SHADE₇>function
SHADE₇>function1, . . . , function4
```

When executed, SHADE₇> plots the specified function(s) on the graph and shades the area above the function with a pattern.

The patterns for shading are automatically assigned in the following order.

<table>
<thead>
<tr>
<th>Function 1</th>
<th>Function 2</th>
<th>Function 3</th>
<th>Function 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical pattern</td>
<td>Diagonal pattern, lower left to upper right</td>
<td>Diagonal pattern, upper left to lower right</td>
<td>Horizontal pattern</td>
</tr>
</tbody>
</table>

When you specify multiple functions, the shading is done sequentially.

```
SHADE₇>SSIN X+X ≤X
```

![Graph Example](image-url)
Shading Areas below a Function

\[ \text{SHADE}_Y(\text{DRAW DRAW, item 7}) \text{ takes up to four arguments (functions of } X). \]

\[ \text{SHADE}_Y(\text{function}_1, \ldots, \text{function}_4) \]

When executed, \text{SHADE}_Y plots the specified function(s) on the graph and shades the area below the function with a pattern.

The patterns for shading are automatically assigned in the following order.

<table>
<thead>
<tr>
<th>Function</th>
<th>Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Horizontal pattern.</td>
</tr>
<tr>
<td>2</td>
<td>Diagonal pattern, upper left to lower right.</td>
</tr>
<tr>
<td>3</td>
<td>Diagonal pattern, lower left to upper right.</td>
</tr>
<tr>
<td>4</td>
<td>Vertical pattern.</td>
</tr>
</tbody>
</table>

Note that the patterns are assigned in reverse order from the \text{SHADE}_Y patterns.

When you specify multiple functions, the shading is done sequentially.

\[ \text{SHADE}_Y(\text{SIN } X < 2) \]
Shading a Graph

SHADE( DRAW DRAW, item 8) shades the area on a graph that is below one specified function and above another, between two X values. SHADE is not an interactive operation. It draws lowerfunc and upperfunc in terms of X on the current graph and shades the area that is specifically above lowerfunc and below upperfunc. Only the areas where lowerfunc < upperfunc are shaded.

You can specify the shading resolution (an integer between 1 and 9). If none is specified, 1 is used. resolution=1 shades every pixel. resolution=2 shades every second pixel. resolution=3 shades every third pixel, and so on.

Optionally, you can specify Xleft (the left boundary) and Xright (the right boundary) for the shaded area. If Xleft or Xright is not specified, XMIN and XMAX are used.

SHADE(lowerfunc,upperfunc)
SHADE(lowerfunc,upperfunc,resolution)
SHADE(lowerfunc,upperfunc,resolution,Xleft)
SHADE(lowerfunc,upperfunc,resolution,Xleft,Xright)
Drawing Points

To display the DRAW POINTS menu, press [F6] [DRAW] [2]. What happens when you select an item from this menu depends on whether or not a graph is displayed when you access the menu, as described under each operation.

**DRAW POINTS Menu**

<table>
<thead>
<tr>
<th>DRAW POINTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: PT-ON()</td>
</tr>
<tr>
<td>2: PT-OFF()</td>
</tr>
<tr>
<td>3: PT-CHANGE()</td>
</tr>
</tbody>
</table>

**Drawing a Point Directly on a Graph**

To draw points directly on a graph:

1. When a graph is displayed, select PT-ON() from the DRAW POINTS menu (item 1).

2. Position the cursor at the location on the display where you want to draw the point. Press [ENTER]. The point is drawn.

![Graph with points drawn](image)

To continue to draw points, repeat step 2. To cancel PT-ON(), press [CLEAR].
**PT-OFF( PT-CHANGE(**

Procedures for using **PT-OFF(** (point off, **DRAW POINTS**, item 2) to turn off (erase) a point and **PT-CHANGE(** (point change, **DRAW POINTS**, item 3) to toggle (reverse) a point on and off are the same as for **PT-ON(**.

**From the Home Screen or a Program**

When you use these instructions from the Home screen or a program, you must specify the X-coordinate and the Y-coordinate of the point as arguments for the instructions.

**PT-ON(** turns on the point at \((X,Y)\). **PT-OFF(** turns the point off, and **PT-CHANGE(** toggles the point between on and off.

**PT-ON(X,Y)**
**PT-OFF(X,Y)**
**PT-CHANGE(X,Y)**
Draw Operations

All points, lines, and shading drawn on a graph with DRAW operations are temporary. They remain only until you execute a CLRDRW (clear drawing) instruction or a change prompts Smart Graph to replot the graph, at which time all drawn elements are erased.

**Clearing a Drawing**

When a Graph Is Displayed

To clear drawings from the currently displayed graph, select **CLRDRW** from the **DRAW** menu (item 1). The current graph is plotted and displayed immediately with no drawn elements.

Note that CLRDRW gives you a quick way to replot the current graph, in addition to clearing the current drawings.

From the Home Screen or a Program

Begin on a blank line on the Home screen or in the program editor. Select **CLRDRW** from the **DRAW** menu (item 1). The instruction is copied to the cursor location.

When the instruction is executed, it clears all drawings from the current graph and displays the message **DONE**. The next time you display the graph, all drawn points, lines, and shaded areas will be gone.

| CLRDRW | DONE |
This chapter describes the list features of the TI-80. The TI-80 can store up to six lists. A list, depending on available memory, can have up to 99 elements.

**Chapter 8: Lists**

<table>
<thead>
<tr>
<th>Chapter Contents</th>
<th>Page</th>
</tr>
</thead>
<tbody>
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<td>8-2</td>
</tr>
<tr>
<td>About Lists</td>
<td>8-3</td>
</tr>
<tr>
<td>LIST OPS Operations</td>
<td>8-6</td>
</tr>
<tr>
<td>LIST MATH Operations</td>
<td>8-9</td>
</tr>
</tbody>
</table>
Getting Started: Generating a Sequence

Getting Started is a fast-paced introduction. Read the chapter for details.

Calculate the first eight terms of the sequence \(1/A^2\) and display them in fraction form.

The \(\text{SEQ}(\) function returns a list of values based on five arguments: an expression, a variable to be incremented, a beginning value, an ending value, and an increment. For this example, the beginning value is 1, the ending value is 8, and the increment is 1.

1. Begin on a blank line on the Home screen. Press \(2^{\text{nd}}\) [157] to display the \(\text{LIST OPS}\) menu.

2. Press 4 to select \(\text{SEQ}(\). The function name is copied to the cursor location on the Home screen.

3. Press 1 \(\alpha\) [\(A\)] \(1\) \(\alpha\) [\(A\)] \(1\) \(8\) \(1\) \(1\) \(\text{STO}\) \(2^{\text{nd}}\) [157]. Press \(\text{ENTER}\) to generate the list and store it in \(L1\). The list is displayed on the Home screen.

4. Use \(\uparrow\) to scroll the list to see all of the elements.

5. Press \(\alpha\) [\(\text{FRAC}\)] 4 (to select \(\text{FRAC}\)). On the Home screen, \(\text{ANS}\) is typed automatically, followed by \(\text{FRAC}\).

6. Press \(\text{ENTER}\) to show the sequence in fraction form. Use \(\uparrow\) to scroll the list to see all of the elements.
The TI-80 has six list variables: L1, L2, L3, L4, L5, and L6. On the Home screen or in a program, you can use, enter, store, and display lists. The list names are on the keyboard. A list may have a maximum of 99 elements.

**Using a List in an Expression**
To use a list in an expression, you may:
- Use the name of the list (L1, L2, L3, L4, L5, or L6) in the expression.

```
5+L1
```
- Enter the list directly in the expression.

```
5+{1,2,3}:
```

**Entering a List in an Expression**
1. Press \( 	ext{2nd} \) [1] to indicate the beginning of the list.
2. Enter a value (which can be an expression) for each element in the list, separated by commas.
3. Press \( 	ext{2nd} \) [1] to indicate the end of the list.

```
2\{1\,2\,3\,4\,5\,6\}\:
```

The expression is evaluated when the entry is executed. Commas are required on entry to separate elements, but they are not displayed on output.

**Saving a List in Memory**
You can save a list in memory in two ways:
- Enter the list in the STAT list editor (Chapter 9).
- Enter the list on a blank line on the Home screen or in a program, press \( 	ext{STO} \), and then enter the name of the list (L1, L2, L3, L4, L5, or L6).

```
2\{1\,2\,3\,4\,5\,6\}\:
```

**Copying One List to Another**
To copy a list, store it to another list.

```
L6-->L5
```

Lists 8-3
### Displaying a List on the Home Screen

To display the contents of a list on the Home screen, enter the name of the list, and press \[ \text{ENTER} \].

A open brace (\{) without a corresponding close brace (\}) indicates that a list is too long to be displayed in its entirety. Press \[ \downarrow \] and \[ \uparrow \] to display the rest of the list.

\[
\begin{align*}
\{1, 10, 15, 20, 25, 3\} & \quad \{1, 10, 15, 20, 25, 30\}
\end{align*}
\]

### Storing to or Recalling a List Element

You can store a value to or recall a value from a specific list element. Enter the name of the list, followed by the number of the element in parentheses. You can store to any element within the currently defined list dimensions or one beyond.

\[
\text{listname}(\text{element})
\]

You can also edit a list by means of the STAT list editor (Chapter 9).

### Lists in Graphing

You can use a list in a \( Y= \) expression. However, the list must be used in such a way that it resolves to a single value; for example, \( Y_1 = X \cdot \text{SUM}(1/(1.1^{1,2,3})) \).

**Note:** Unlike the TI-82 and TI-85, you cannot use a list to graph a family of curves.
A list can be used to input several values for certain functions. (Other chapters and Appendix A state when a list is valid.) The function is evaluated for each element in the list, and a list is returned.

- If a list is used with a function, the function must be valid for every element in the list.

\[
\frac{1}{\{1, 0, 1\}}
\]

This returns an error because 1 is divided by 0.

- If two lists are used with a two-argument function, the lengths of the lists must be the same. The answer is a list in which each element is calculated by evaluating the function using the corresponding elements in the lists.

\[
\{1, 2\} + \{3; 5; 6\} = \{4, 7, 9\}
\]

- If a list and a value are used with a two-argument function, the value is used with each element in the list.

\[
\{1, 2\} + 4 = \{5, 6, 7\}
\]
### LIST OPS Operations

Press \( \text{[2nd]} \text{ [LIST]} \) to display the list operations on the LIST OPS menu.

<table>
<thead>
<tr>
<th>LIST OPS Menu</th>
<th>OPS</th>
<th>MATH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: SORTA(</td>
<td></td>
<td>MATH</td>
</tr>
<tr>
<td>2: SORTD(</td>
<td></td>
<td>MATH</td>
</tr>
<tr>
<td>3: DIM</td>
<td></td>
<td>MATH</td>
</tr>
<tr>
<td>4: SEQ(</td>
<td></td>
<td>MATH</td>
</tr>
</tbody>
</table>

Note: SORTA( and SORTD( are the same as SORTA( and SORTD( on the STAT EDIT menu.

- SORTA( (sort ascending, LIST OPS, item 1) and SORTD( (sort descending, LIST OPS, item 2) have two uses.
  - With one list name, they sort the elements of an existing list and update the list in memory.
  - With two to six list names, they sort the first list and then sort the remaining lists as dependent lists, placing their elements in the same order as their corresponding elements in the first list. This allows you to keep sets of related data in the same order when you sort lists.

All of the lists to be sorted must be the same length. The sorted lists are updated in memory.

Note: You can reference a specific list only once in these instructions.

- SORTA(listname)
- SORTA(keylistname,dependlist1,dependlist2,...)
- SORTD(listname)
- SORTD(keylistname,dependlist1,dependlist2,...)

![SORTA and SORTD examples](image-url)
DIM (dimension, LIST OPS, item 3) returns the length (number of elements) of the specified list.

\[ \text{DIM} \ \text{list} \]

Creating a List with DIM

DIM is used with \texttt{STO} to create a new list with a specified number of elements. The elements of the new list are zeros.

\[ \text{DIM} \ \text{listname} \]

Redimensioning a List with DIM

DIM is also used with \texttt{STO} to redimension an existing list.

- The elements in the old list that are within the new dimension are not changed.
- Any elements in the old list that are outside the new dimension are eliminated.
- Any additional elements that are created are zeros.

\[ \text{DIM} \ \text{listname} \]
SEQ( sequence, LIST OPS, item 4) requires five arguments: an expression, a variable to be incremented, a beginning value, an ending value, and an increment. SEQ( returns a list in which each element is the result of the evaluation of expression with regard to variable for values ranging from begin to end at steps of increment.

SEQ(expression,variable,begin,end,increment)

The variable need not be defined in memory. The increment can be negative.

SEQ(0,0,1,11,3)

<1 16 49 100>

SEQ( can be used to generate a list of index numbers. This kind of list can be useful in data analysis.

SEQ(0,0,1994,2000)

<0 1 1994 1995 1996>
### LIST MATH Operations

Pressing \( \text{[2nd]} \text{ [LIST]} \text{ [2]} \) accesses the list math operations on the LIST MATH menu.

<table>
<thead>
<tr>
<th>LIST MATH Menu</th>
<th>OPS</th>
<th>MATH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: MIN(</td>
<td></td>
<td>Returns minimum element of a list.</td>
</tr>
<tr>
<td>2: MAX(</td>
<td></td>
<td>Returns maximum element of a list.</td>
</tr>
<tr>
<td>3: MEAN(</td>
<td></td>
<td>Returns mean of a list.</td>
</tr>
<tr>
<td>4: MEDIAN(</td>
<td></td>
<td>Returns median of a list.</td>
</tr>
<tr>
<td>5: SUM</td>
<td></td>
<td>Returns sum of all elements in a list.</td>
</tr>
<tr>
<td>6: PROD</td>
<td></td>
<td>Returns product of all elements in a list.</td>
</tr>
</tbody>
</table>

Note: MIN\( (\) and MAX\( (\) are the same as MIN\( (\) and MAX\( (\) on the MATH NUM menu.

#### MIN\( (\) and MAX\( (\)

\( \text{MIN(} \) (minimum, LIST MATH, item 1) or \( \text{MAX(} \) (maximum, LIST MATH, item 2) returns the smallest or largest element of the specified list. If two lists are compared, it returns a list of the smaller or larger of each pair of elements in the two lists.

\[
\text{MIN}(\text{list}) \quad \text{MAX}(\text{list}) \\
\text{MIN}(\text{listA, listB}) \quad \text{MAX}(\text{listA, listB})
\]

\[
\text{MIN}\{1, 2, 3\} \quad \text{MAX}\{1, 2, 3\}
\]

#### MEAN\( (\)

\( \text{MEAN(} \) (LIST MATH, item 3) returns the mean value of the list. \( \text{MEDIAN(} \) (LIST MATH, item 4) returns the median value of the list.

\[
\text{MEAN}(\text{list}) \quad \text{MEDIAN}(\text{list})
\]

If a second list is given, it is interpreted as the frequency of the elements in the list.

\[
\text{MEAN}(\text{list, frequency}) \quad \text{MEDIAN}(\text{list, frequency})
\]

\[
\text{MEAN}\{1, 2, 3\} \quad \text{MEDIAN}\{1, 2, 3\}
\]

\[
\text{MEAN}\{1, 2, 3\} \times 2 \quad \text{MEDIAN}\{1, 2, 3\} \times 2
\]

\[
1.51428571 \quad 1.5
\]
**SUM**

**SUM** (summation, **LIST MATH**, item 5) returns the sum of the elements in the specified list.

```
SUM list
```

```
{5, 2, 3} → li
SUM li 10
```

**PROD**

**PROD** (product, **LIST MATH**, item 6) returns the product of the elements of the list.

```
PROD list
```

```
{5, 2, 3} → 30
```

**Sums and Products of Numeric Sequences**

You can combine **SUM** or **PROD** with **SEQ** to obtain:

\[
\sum_{x=\text{lower}}^{\text{upper}} \text{expression}(x) \quad \prod_{x=\text{lower}}^{\text{upper}} \text{expression}(x)
\]

To evaluate \( \sum 2^{(N-1)} \) from \( N=1 \) to 4:

```
SUM SEQC(2^(N-1), \{N, 1, 4\}) 15
```
Chapter 9: Statistics

This chapter describes the tools for analyzing statistical data on the TI-80. These include entering lists of data, calculating statistical results, fitting data to a model, and plotting data.

<table>
<thead>
<tr>
<th>Chapter Contents</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
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<td>9-2</td>
</tr>
<tr>
<td>Setting Up a Statistical Analysis</td>
<td>9-8</td>
</tr>
<tr>
<td>The STAT List Editor</td>
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<tr>
<td>Viewing, Entering, and Editing Lists</td>
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<tr>
<td>Sorting and Clearing Lists</td>
<td>9-13</td>
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<td>Statistical Analysis</td>
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<td>Types of Statistical Analysis</td>
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<td>9-17</td>
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<td>Statistical Plotting</td>
<td>9-18</td>
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<tr>
<td>Statistical Analysis in a Program</td>
<td>9-22</td>
</tr>
<tr>
<td>Statistical Plotting in a Program</td>
<td>9-23</td>
</tr>
</tbody>
</table>
Getting Started: Building Height and City Size

Getting Started is a fast-paced introduction. Read the chapter for details.

Determine a linear equation to fit the data below. Enter the data, and perform a linear regression. Then plot the data. Predict how many buildings of more than 12 stories you would expect to find in a city of 300 thousand people.

<table>
<thead>
<tr>
<th>Population in Thousands</th>
<th>Buildings &gt; 12 Stories</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>4</td>
</tr>
<tr>
<td>500</td>
<td>31</td>
</tr>
<tr>
<td>800</td>
<td>42</td>
</tr>
<tr>
<td>250</td>
<td>9</td>
</tr>
<tr>
<td>550</td>
<td>20</td>
</tr>
<tr>
<td>750</td>
<td>55</td>
</tr>
</tbody>
</table>

1. To clear any existing lists, press \texttt{STAT} \texttt{4} to copy \texttt{CLRLIST} to the Home screen.

2. Press \texttt{2nd} \texttt{[L-1]} \texttt{2nd} \texttt{[L-3]} \texttt{2nd} \texttt{[L-1]} \texttt{2nd} \texttt{[L-4]} \texttt{[ENTER]}. The message \texttt{DONE} is displayed.

3. Press \texttt{STAT} \texttt{1} to display the \texttt{STAT} list editor. Enter \texttt{150} to represent 150,000 for the population of the first city. As you type, the value is displayed on the bottom line.

4. Press \texttt{[ENTER]}. The value is shown in the first element of \texttt{L1}, and the cursor moves to the second element in the same list.
5. Enter the remaining elements of L1. Press:
   500 [ENTER].
   800 [ENTER].
   250 [ENTER].
   550 [ENTER].
   750 [ENTER].

6. Press 1 to move to the first element of list L2.

7. Enter the elements (number of buildings with more than 12 stories) of L2. Press:
   4 [ENTER].
   31 [ENTER].
   42 [ENTER].
   9 [ENTER].
   20 [ENTER].
   55 [ENTER].

8. You can sort the data by size of city. Press [2nd] [QUIT] CLEAR to return to a clear Home screen. Press STAT 2 to select SORTA, which is copied to the Home screen. Press [2nd] [L1] to select the independent list and then press 1 2nd [L2] to select the dependent list. Press 1 [ENTER]. The message DONE is displayed. The lists have been updated in memory.

9. Press STAT 1 to display the sorted lists in the STAT list editor.
After entering and sorting the data, define the STAT PLOTS and Window variables; then perform a linear regression \((aX + b)\).

10. Press \(\text{2nd} \ \text{ENTER}\) to display the STAT PLOTS screen.

11. Press 1 to display the PLOT1 screen. Move the cursor to ON, if necessary, and press \text{ENTER} to turn PLOT1 on. Leave TYPE as scatter plot (\(\Large\bullet\)), XL (independent list) as L1, YL (dependent list) as L2, and Mark as \(\Large\bullet\).

12. Press \text{WINDOW} to display the Window variables. Enter the following values.
   - 0 for XMIN
   - 1000 for XMAX
   - 100 for XSCL
   - \(-15\) for YMIN
   - 100 for YMAX
   - 10 for YSCL

13. Press \text{STAT} \(\text{A}\) to display the STAT CALC menu.

14. Press 3 to select LINREG\((aX+b)\), which is copied to the Home screen. Press \(\text{2nd} \ [1] \ \text{[+] \[2]} \ \text{ENTER}\).

   The least-squares linear regression is calculated; the display shows the values for \(a\) (slope), \(b\) (y-intercept), and \(r\) (correlation coefficient).
Store the regression equation into the Y= list and graph it.

15. In **FUNC** mode, press **Y=** to display the Y= editor. Press **CLEAR** to clear Y1, if necessary. Turn off all other functions, if necessary.

16. Press **VARS** to display the **VARS** menu.

17. Press 2 to select **STATISTICS...**, and press **+** to display the **VARS EQ** menu.

18. Press 5 to select **REGEQ**, which copies the linear regression to the Y= editor screen.

   **Note**: Each time you calculate a regression, the regression equation (REGEQ) is updated.

19. Press **GRAPH**. The data points are plotted (□), and then the regression line is drawn.

20. Press **TRACE** and then **+** to trace the points in **PLOT1**, as indicated by **P1** in the upper right corner of the display.

   Press **+** to move to **Y1**, and continue tracing the function.
You can enter expressions to define lists in the STAT list editor. For example, you can now define predicted values and residuals (the differences between the observed values and the predicted values) for this problem.

21. Press [STAT] 1 to display the STAT list editor. Press [D] [C] to move the cursor onto the name L3.

22. Press [2nd] [Y-VARS] 1 to select Y1, and then press [1] [2nd] [L1] [1]. This defines L1 as the values predicted by the LINREG line.

23. Press [ENTER] to store the values in L3.

24. To store the residuals in L4, press [D] [C] to move the cursor onto the name L4. To enter L4 = L2 - L3, press [2nd] [L2] (the observed) [+] [2nd] [L3] (the predicted) [ENTER].

25. Press [2nd] [STAT PLOT]. Press 1 to select PLOT1. Move the cursor to OFF, and press [ENTER] to turn the plot off.

26. Press [2nd] [STAT PLOT] 2 to select PLOT2. Move the cursor to ON and press [ENTER] to turn the plot on, if necessary. Press [D] [C] [ENTER] to define XL as L1. Press [D] [C] [D] [ENTER] to define YL as L4. Press [D] [C] [ENTER] to set MARK as +.
Plot the residuals, and predict how many buildings of 12 or more stories there are in a city with a population of 300 thousand.

27. Press $\text{Y} \rightarrow \text{4 ENTER}$ to turn off Y1.

28. Press [WINDOW], and change the Window variable values to best show the residuals. Use the minimum and maximum values of L4 (10.31862745 and 10.74019608) as guidelines for setting YMIN and YMAX.

29. Press [GRAPH] to plot the residuals.

   + marks each residual value.


   The value of Y1 (the linear regression equation) for X=300 (which represents 300 thousand city population) is shown. Remember to round the number mentally to an integer (13) to represent whole buildings.
Setting Up a Statistical Analysis

The data for statistical analyses is stored in lists. The TI-80 has six list variables (L1 through L6) that you can use in STAT calculations. Several types of statistical analyses are available.

Steps

Follow these basic steps to perform statistical analyses.

1. Enter the statistical data in lists (pages 9-9 through 9-13).

2. Select the type of statistical calculations you want to do (pages 9-14 through 9-16), and specify the list names for the data.

3. Calculate the statistical variables, or fit the data to a model (page 9-17).

4. Plot the data (pages 9-18 through 9-21).
The STAT List Editor

Pressing STAT accesses the STAT list editor and several instructions for use with lists (L₁ through L₆). The instructions are discussed on page 9-13.

<table>
<thead>
<tr>
<th>STAT EDIT Menu</th>
<th>EDIT</th>
<th>CALC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: EDIT...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2: SORTA(</td>
<td>Sorts list in ascending order.</td>
<td></td>
</tr>
<tr>
<td>3: SORTD(</td>
<td>Sorts list in descending order.</td>
<td></td>
</tr>
<tr>
<td>4: CLRLIST</td>
<td>Deletes all elements of list.</td>
<td></td>
</tr>
</tbody>
</table>

Displaying the STAT List Editor

The STAT list editor gives you an easy environment in which to enter or edit lists. You can also create lists directly from the keyboard (Chapter 8), if you prefer.

To display the STAT list editor, press STAT and then press 1 or ENTER to select EDIT... from the STAT EDIT menu.

The top line of the STAT list editor displays the names of the lists (even if the list is empty). The center portion displays up to six elements of two lists, showing the values of the elements (abbreviated to six digits if necessary). The full value of the current element (indicated by the rectangular cursor) is shown on the bottom line.

Entering List Elements in the STAT List Editor

To enter a list into the STAT list editor:
1. Display the STAT list editor.
2. Enter the first value in the list, and press ENTER or ». The value is entered, and the rectangular cursor moves down to the next position.
3. Continue until you enter all the data in the list.

Press » and ‹ in the editor to move between lists.

**Note:** You may enter an expression, which is evaluated when you press ENTER, ‹, or ». 

Leaving the STAT List Editor

To leave the STAT list editor:
- Select another screen by pressing the appropriate key.
- Press Í or [QUIT] to return to the Home screen.
Viewing, Entering, and Editing Lists

The STAT list editor has two “contexts,” viewing and editing. The current context determines the result of a key press. In both contexts, the full value of the highlighted element is displayed on the bottom line.

### Viewing Context

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>9</td>
<td>0</td>
<td>.</td>
<td>M</td>
<td>A</td>
<td>2</td>
</tr>
</tbody>
</table>

In the viewing context, you can move quickly from one list element to the next.

- `1` or `9`: Moves the rectangular cursor to the previous or next list.
- `2` or `8`: Moves the rectangular cursor within the current column. On row 1, `2` moves the cursor to the list name.
- `M`: Clears the value on the bottom line.
- A: Any entry character: Clears the value on the bottom line; copies the character to the bottom line.
- `1/2`: Inserts a list element (value is zero).
- `4`: Deletes the current list element and closes up the list.

### Editing Context

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>9</td>
<td>0</td>
<td>.</td>
<td>M</td>
<td>A</td>
<td>2</td>
</tr>
</tbody>
</table>

In the editing context, an edit cursor is active on the bottom line; and you can change the value of the current list element. You can also move the cursor onto the list name and edit the entire list at once.

- `1` or `9`: Moves the edit cursor within the value.
- `2` or `8`: Stores the value on the bottom line to the list element; moves the rectangular cursor within the column. On row 1, `2` moves the cursor to the list name.
- `M`: Clears the value on the bottom line.
- A: Any entry character: Copies the character to the edit-cursor location on the bottom line. If it is the first character typed, the value on the bottom line is cleared.
- `1/2`: Activates the insert cursor.
- `4`: Deletes a character.
Deleting a List

You can delete the contents of a list in several ways:

- With the CLRLIST instruction (page 9-13).
- Through the MEMORY menu (Chapter 12).
- In the STAT list editor, by pressing [ ] to move onto the list name and then pressing CLEAR ENTER.
- In the STAT list editor, by deleting each element.
- On a command line, by entering 0 DIM listname.

Editing a List Element

To edit a list element:

1. Display the STAT list editor.
2. Move the rectangular cursor to the element you want to change.
3. Press [ ] to switch to the editing context. Then:
   - Change the current value by inserting, deleting, or typing over digits.
   - Press an entry key, such as a number or letter, to begin an entry. This automatically clears the value.
   - Press CLEAR to clear the entire value and then enter a new value.

   Note: If you clear a value by mistake, you can immediately press [ ] to restore the value at the rectangular cursor.
4. Press [ ] to store the new value and move to another element.

Note: You may enter an expression, which is evaluated when you press [ ], [ ], or [ ].
You can enter or edit an entire list by moving the cursor to a list name on the top line of the STAT list editor and then pressing ENTER. The bottom line displays \( L_n = L_n \cdot 1 \), if there is data already in the list. Type any expression that returns a list, and press ENTER. The new list is displayed.

**Entering an Entire List**

To enter an entire list:

1. Press STAT ENTER. Enter several elements in \( L_1 \).

2. Press 2 and 9 as many times as necessary to move the cursor to the list name \( L_2 \).

3. Press \( \boxed{2} \) \( \boxed{6} \) \( \boxed{2} \). This is the expression that will define the elements in \( L_2 \).

4. Press ENTER to define and display \( L_2 \).

**Editing an Entire List**

To replace an existing list:

1. Move the cursor to the list name \( L_2 \). \( L_2 = L_2 \cdot 1 \) is displayed.

2. Enter a new expression to replace the existing values in \( L_2 \), \( \boxed{2} \) \( \boxed{6} \) \( \boxed{2} \) \( \boxed{3} \), for example. Then press ENTER. The values in \( L_2 \) are replaced, and the new values are displayed.
Sorting and Clearing Lists

Items 2 through 4 on the STAT EDIT menu—SORTA(, SORTD(, and CLRLIST—let you sort or clear list data. Pressing $	ext{STAT}$ displays these instructions, and selecting an item copies the name of the instruction to the Home screen. Note that SORTA( and SORTD( are the same as SORTA( and SORTD( on the LIST OPS menu (Chapter 8).

**SORTA(**  
**SORTD(**  
**CLRLIST**

**SORTA( (sort ascending, STAT EDIT, item 2) and SORTD( (sort descending, STAT EDIT, item 3) have two uses.**

- With one list name, they sort the elements of an existing list and update the list in memory.

- With two to six list names, they sort the first list and then sort the remaining lists as dependent lists, placing their elements in the same order as their corresponding elements in the first list. This lets you sort two-variable data on $X$ and keep the data pairs together.

All of the lists to be sorted must be the same length. The sorted lists are updated in memory.

**Note:** You can reference a specific list only once in these instructions.

**SORTA(listname)**  
**SORTA(keylistname,dependlistA,dependlistB,...)**  
**SORTD(listname)**  
**SORTD(keylistname,dependlistA,dependlistB,...)**

**CLRLIST**

**CLRLIST** (clear list, STAT EDIT, item 4) clears (deletes) the elements of one or more lists.

**CLRLIST listnameA,listnameB,...**

Statistics  9-13
Statistical Analysis

Pressing \( \text{STAT} \) \( \boxed{1} \) accesses the STAT CALC menu, where you select and perform statistical calculations. The TI-80 can analyze one-variable or two-variable statistics. Both can have associated frequency lists.

<table>
<thead>
<tr>
<th>STAT CALC Menu</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDIT CALC</td>
<td></td>
</tr>
<tr>
<td>1: 1-VAR STATS</td>
<td>Calculates 1-variable statistics.</td>
</tr>
<tr>
<td>2: 2-VAR STATS</td>
<td>Calculates 2-variable statistics.</td>
</tr>
<tr>
<td>3: LINREG(aX+b)</td>
<td>Fits data to linear model.</td>
</tr>
<tr>
<td>4: QUADREG</td>
<td>Fits data to quadratic model.</td>
</tr>
<tr>
<td>5: LINREG(a+bX)</td>
<td>Fits data to linear model.</td>
</tr>
<tr>
<td>6: LNREG</td>
<td>Fits data to logarithmic model.</td>
</tr>
<tr>
<td>7: EXPREG</td>
<td>Fits data to exponential model.</td>
</tr>
<tr>
<td>8: PWRREG</td>
<td>Fits data to power model.</td>
</tr>
</tbody>
</table>

To select and perform statistical calculations:

1. Select a calculation type by pressing its corresponding number on the STAT CALC menu. The name of the calculation is copied to the Home screen.

2. Enter the name(s) of the list(s) to be used in the calculation. If you enter more than one list name, separate them by commas.

3. Press ENTER to perform the calculation and display the results.

For all of the calculation types, you can include a list of data occurrences, or frequencies. These indicate how many times the corresponding data points or data pairs occur in the data set you are analyzing.

For example, if \( L1=\{15.5,12.1,9.8,14.7,15\} \) and \( L2=\{1,4,1,3,3\} \), then the instruction 1-VAR STATS \( L1,L2 \) would assume that 15.5 occurred one time, 12.1 occurred four times, 9.8 occurred one time, and so on.

Frequencies must be greater than or equal to zero. At least one frequency in the list must be greater than zero.

Noninteger frequencies are valid. This is useful in entering frequencies expressed as percentages or parts that add up to 1. Noninteger frequencies, however, may prevent the calculation of certain variables.
Types of Statistical Analysis

These calculations return statistical results based on the list(s) you reference. If you reference a third list name as an argument for 2-VAR STATS or any of the regression models, the list is interpreted as the frequencies of occurrence for the data pairs in the first two lists.

1-VAR STATS  
1-VAR STATS (one-variable statistics, STAT CALC, item 1) analyzes data with one measured variable and calculates statistical results as indicated on page 9-17.

If you reference two list names, the second list is interpreted as the frequency of occurrence for each data point in the first list.

1-VAR STATS listname  
1-VAR STATS Xlistname, freqlistname

2-VAR STATS  
2-VAR STATS (two-variable statistics, STAT CALC, item 2) analyzes paired data between which there is a relationship. This option calculates statistical results as indicated on page 9-17.

The first list you reference is the independent variable (X list). The second list is the dependent variable (Y list). If you reference a third list name, it is interpreted as the frequency of occurrence for each data pair in the first two lists.

2-VAR STATS Xlistname, Ylistname  
2-VAR STATS Xlistname, Ylistname, freqlistname

LINREG (aX+b)  
LINREG (aX+b) (linear regression, STAT CALC, item 3) fits the data to the model y=ax+b using a least-squares fit and x and y. It displays a (slope), b (y-intercept), and r (correlation coefficient).

LINREG (aX+b) Xlistname, Ylistname  
LINREG (aX+b) Xlistname, Ylistname, freqlistname

<table>
<thead>
<tr>
<th>LINREG(aX+b)</th>
<th>L1</th>
<th>L2</th>
</tr>
</thead>
<tbody>
<tr>
<td>a = 0.038870</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b = -0.008078</td>
<td></td>
<td></td>
</tr>
<tr>
<td>r = 0.955484</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Statistics 9-15
QUADREG (quadratic regression, STAT CALC, item 4) fits the data to the second-order polynomial \( y=ax^2+bx+c \). It displays \( a \), \( b \), and \( c \). For three data points the equation is a polynomial fit; for four or more, it is a polynomial regression. At least three data points are required.

\[
\text{QUADREG Xlistname,Ylistname}
\]

LINREG (linear regression, STAT CALC, item 5) fits the data to the model equation \( y=a+bx \) using a least-squares fit and \( x \) and \( y \). It displays \( a \), \( b \), and \( r \) (correlation coefficient).

\[
\text{LINREG (a+bX) Xlistname,Ylistname}
\]

LNREG (logarithmic regression, STAT CALC, item 6) fits the data to the model equation \( y=a+b \ln(x) \) using a least-squares fit and transformed values \( \ln(x) \) and \( y \). It displays \( a \), \( b \), and \( r \) (correlation coefficient).

\[
\text{LNREG Xlistname,Ylistname}
\]

EXPREG (exponential regression, STAT CALC, item 7) fits the data to the model equation \( y=ab^x \) using a least-squares fit and transformed values \( x \) and \( \ln(y) \). It displays \( a \), \( b \), and \( r \) (correlation coefficient).

\[
\text{EXPREG Xlistname,Ylistname}
\]

PWRREG (power regression, STAT CALC, item 8) fits the data to the model equation \( y=ax^b \) using a least-squares fit and transformed values \( \ln(x) \) and \( \ln(y) \). It displays \( a \), \( b \), and \( r \) (correlation coefficient).

\[
\text{PWRREG Xlistname,Ylistname}
\]

Note: Calculations for \( \bar{x} \), \( \Sigma X \), \( \Sigma X^2 \), \( SX \), \( aX \), \( \bar{y} \), \( \Sigma Y \), \( \Sigma Y^2 \), \( SY \), \( \sigma Y \), and \( \Sigma XY \) are calculated using transformed values for LNREG, EXPREG, and PWRREG.
The statistical variables are calculated as indicated below. Some are displayed when 1-VAR STATS or 2-VAR STATS are calculated. You can access these variables for use in expressions through the VARS STATISTICS... menus. If you edit a list, all statistical variables are cleared.

### Statistical Variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>1-VAR STATS</th>
<th>2-VAR STATS</th>
<th>LN, LN, EXP, PWR, REGS</th>
<th>QUADREG</th>
<th>VARS Menu</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\bar{x}$ (mean of X values)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>X/Y</td>
</tr>
<tr>
<td>$\sum X$ (sum of X values)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Σ</td>
</tr>
<tr>
<td>$\sum X^2$ (sum of $X^2$ values)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Σ</td>
</tr>
<tr>
<td>SX (sample standard deviation of X)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>X/Y</td>
</tr>
<tr>
<td>σX (population standard deviation of X)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>X/Y</td>
</tr>
<tr>
<td>n (number of data points)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>X/Y</td>
</tr>
<tr>
<td>$\bar{y}$ (mean of Y values)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>X/Y</td>
</tr>
<tr>
<td>$\sum Y$ (sum of Y values)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Σ</td>
</tr>
<tr>
<td>$\sum Y^2$ (sum of $Y^2$ values)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Σ</td>
</tr>
<tr>
<td>SY (sample standard deviation of Y)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>X/Y</td>
</tr>
<tr>
<td>σY (population standard deviation of Y)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>X/Y</td>
</tr>
<tr>
<td>$\sum XY$ (sum of $X \cdot Y$)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Σ</td>
</tr>
<tr>
<td>MINX (minimum of X values)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>X/Y</td>
</tr>
<tr>
<td>MAXX (maximum of X values)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>X/Y</td>
</tr>
<tr>
<td>MINY (minimum of Y values)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>X/Y</td>
</tr>
<tr>
<td>MAXY (maximum of Y values)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>X/Y</td>
</tr>
<tr>
<td>Q1 (1st quartile)</td>
<td>✓</td>
<td>X</td>
<td>BOX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MED (median)</td>
<td>✓</td>
<td>X</td>
<td>BOX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q3 (3rd quartile)</td>
<td>✓</td>
<td>X</td>
<td>BOX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a, b (regression/fit coefficients)</td>
<td>✓</td>
<td>X</td>
<td>EQ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a, b, c (quadratic coefficients)</td>
<td>✓</td>
<td>X</td>
<td>EQ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>r (correlation coefficient)</td>
<td>✓</td>
<td>X</td>
<td>EQ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>REGEQ (regression equation)</td>
<td>✓</td>
<td>X</td>
<td>EQ</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Q1 and Q3

The quartile Q1 is the median of the orinals to the left of MED (median). The quartile Q3 is the median of the orinals to the right of MED.

### Noninteger Frequencies

If a frequency list contains noninteger values, SX and SY are undefined. No values are displayed for them in the statistical results. Q1, MED, and Q3 are also undefined if the frequency list contains noninteger values.

### Large Frequencies

If a frequency list contains a value larger than 99, Q1, MED, and Q3 will not be calculated.

### Zero Frequencies

If the frequency for an element or data pair is zero, the element or data pair is ignored in the calculation.
**Statistical Plotting**

You can plot statistical data that you have entered in lists. The types of plots available include scatter plots, x-y lines, box and whisker plots, and histograms. You can define up to three plots at a time.

**Steps**

To plot statistical data:

1. Enter the statistical data as lists (page 9-9 and Chapter 8).
2. Select the statistical calculations (pages 9-14 through 9-16), and calculate the statistical variables (page 9-17) or fit the data to a model, if desired.
3. Select or deselect Y= equations, as appropriate (Chapter 4).
4. Define the statistical plot (page 9-20).
5. Turn the plot(s) on, if necessary (page 9-21).
6. Define the viewing window (page 9-21 and Chapter 4).
7. Display and explore the graph by pressing [GRAPH], [ZOOM], or [TRACE].

---

**Scatter Plot**

L- (scatter plot) plots the data points from XL (X list) and YL (Y list) as coordinate pairs, showing each point as a box (•), cross (+), or dot (•). XL and YL must be the same length. They can be the same list.

---

**XYLine**

Z- (XYLine) is a scatter plot in which the data points are plotted and connected in the order in which they appear in XL and YL. You may want to sort the lists with SORTA( or SORTD( before plotting.
Box Plot

A box plot (box plot) plots one-variable data. The whiskers on the plot extend from the minimum data point in the set (MINX) to the first quartile (Q1) and from the third quartile (Q3) to the maximum point (MAXX). The box is defined by Q1, the median (MED), and Q3 (page 9-17).

Box plots are plotted with respect to XMIN and XMAX, but ignore YMIN and YMAX. When two box plots are plotted, the first plots at the top of the screen and the second plots in the middle. When three are plotted, the first plots at the top, the second in the middle, and the third at the bottom.

Histogram

A histogram (histogram) plots one-variable data. XSCL determines the width of each bar, beginning at XMIN. (XMAX – XMIN)/XSCL must be ≤ 31. A value occurring on the edge of a bar is counted in the bar to the right.

Frequencies in Stat Plots

The frequency list specified for a statistical plot works just like the frequency lists specified for other statistical calculations (pages 9-14 through 9-16).

If you want to exclude an outlying data point from a plot, enter a zero for that value in the frequency list to prevent having to change the data lists.
To define plots:

1. Press $\boxed{2^{nd}} \text{ [STAT PLOT]}$. The STAT PLOTS screen shows the current plot definitions.

2. Select the plot to define (PLOT1, PLOT2, or PLOT3).

3. If you wish to plot the statistical data immediately, select ON. You can define a plot at any time and leave it OFF. The definition will be available in the future.

4. Select the type of plot. The options change appropriately.
   - \( \bullet \) (scatter plot): XL YL MARK
   - \( \bullet \) (XYLine): XL YL MARK
   - \( \bullet \) (box plot): XL F
   - \( \bullet \) (histogram): XL F

Where:
- XL is the list of independent data.
- YL is the list of dependent data.
- F is the frequency (1 is used if no list is specified).
- MARK is □, +, or ∗.
PLOTSOFF and PLOTSON allow you to turn statistical plots off or on from the Home screen or a program. Used without plot#, they turn all plots off or all plots on. Used with plot#, they turn specific plots off or on.

PLOTSOFF or PLOTSON
PLOTSOFF plot#,plot#, . . .
PLOTSON plot#,plot#, . . .

For example, PLOTSOFF followed by PLOTSON 3 turns all plots off and then turns PLOT3 on.

<table>
<thead>
<tr>
<th>Turning Plots Off or On</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLOTSOFF</td>
</tr>
<tr>
<td>PLOTSON 3 DNE</td>
</tr>
</tbody>
</table>

Defining the Viewing Window
Statistical plots are displayed on the current graph. You may define the viewing window by pressing WINDOW and then entering values for the Window variables.

Tracing a Stat Plot
When you trace a scatter plot or XyLine, tracing begins at the first element in the lists.

When you trace a box plot, tracing begins at MED (the median). Press □ to trace to Q1 and MINX. Press □□ to trace to Q3 and MAXX.

When you trace a histogram, the cursor moves to the top center of each column, starting at the first column.

When you press □ or □□ to move to another plot or Y# function, tracing moves to the current or beginning point on that plot.
**Statistical Analysis in a Program**

You can enter statistical data, calculate statistical results, and fit data to models from a program.

**Entering Stat Data**

Enter the statistical data directly into lists (Chapter 8) in the program.

```
PROGRAM: STNDS
\{3, 5, 3, 2, 5, 2, 6\} \rightarrow L1
\{4, 6, 7, 9, 11\} \rightarrow L2
```

**Statistical Calculations**

To calculate statistical results or fit data to a model from a program:

1. On a blank line in the program editor, select the type of calculation from the `STAT CALC` menu.
2. Enter the names of the lists, separated by commas, to use in the calculation.

```
PROGRAM: STNDS
\{3, 5, 3, 2, 5, 2, 6\} \rightarrow L1
\{4, 6, 7, 9, 11\} \rightarrow L2
```

**Note:** To display a regression equation and coefficients from a program, the regression function must be the last statement in the program. If it is not the last statement, the regression equation will be evaluated and stored, but the results will not be displayed.
To display a statistical plot, you may define the plot(s), then turn the plot(s) on, and then display the graph. If you do not define the plot, the current definitions are used.

### Defining a Statistical Plot in a Program

To define a statistical plot in a program:

1. Enter the data into list(s). On a blank line in the program editor, press \(2\) to display the PLOTS menu.

2. Select the plot to define. \texttt{PLOT1(}, \texttt{PLOT2(}, or \texttt{PLOT3(} is copied to the cursor location.

3. Press \(2\) to display the TYPE menu. Select the type of plot. \texttt{\textbullet} (scatter), \texttt{\textbullet} (XYLine), \texttt{\textbullet} (box), or \texttt{\textbullet} (histogram) is copied to the cursor location.

4. Press \(\) and \(\) to display the MARK menu. Select the mark. \texttt{\textbullet}, \texttt{\textbullet}, or \texttt{\textbullet} is copied to the cursor location.

5. (This step is for \texttt{\textbullet} and \texttt{\textbullet} only.) Press \(\) and \(\) to display the MARK menu. Select the mark. \texttt{\textbullet}, \texttt{\textbullet}, or \texttt{\textbullet} is copied to the cursor location.

6. Press \(\) and \(\) to complete the command line.

7. Press \(\) to copy PLOTSON to the command line and the number of the plot (1, 2, or 3) to turn on. Press \(\) to complete the command line.

Note that PLOTSOFF in the example program ensures that all other plots are turned off.
Displaying a Stat Plot from a Program

To display a plot, use any of the Zoom instructions (Chapter 4), or use the \texttt{DISPGRAPH} instruction (Chapter 10).

\begin{verbatim}
PROGRAM: STAT
  X: Y: 45\rightarrow L1
  Z: X: Y: L2
  \text{PLOT}(L2:L1:L2)
  \text{STANDARD}
\end{verbatim}

\begin{verbatim}
PROGRAM: STAT
  \text{PLOT}OFF
  \text{FIND}
  \text{PLOT}OFF
  \text{PLOT}(L1)
  \text{PLOT}ON
  \text{DISPGRAPH}
\end{verbatim}
# Chapter 10: Programming

This chapter describes specific programming instructions and explains how to enter and execute programs on the TI-80.

<table>
<thead>
<tr>
<th>Chapter Contents</th>
<th>Page</th>
</tr>
</thead>
<tbody>
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<td>10-2</td>
</tr>
<tr>
<td>About TI-80 Programs</td>
<td>10-4</td>
</tr>
<tr>
<td>Creating and Executing Programs</td>
<td>10-5</td>
</tr>
<tr>
<td>Editing Programs</td>
<td>10-6</td>
</tr>
<tr>
<td><strong>PRGM CTL</strong> (Control) Instructions</td>
<td>10-7</td>
</tr>
<tr>
<td><strong>PRGM I/O</strong> (Input/Output) Instructions</td>
<td>10-11</td>
</tr>
<tr>
<td>Calling Other Programs</td>
<td>10-14</td>
</tr>
</tbody>
</table>
Getting Started: Rolling a Die

Getting Started is a fast-paced introduction. Read the chapter for details.

A program is a set of commands that can be executed sequentially, as if they had been entered from the keyboard. Write a simple program to simulate the rolling of a single die. It should prompt for the number of rolls and then store the results of the rolls in a list.

1. Press \texttt{PRGM \{ \}} to display the \texttt{PRGM NEW} menu.

2. Press \texttt{ENTER} to select \texttt{CREATE NEW}. (The keyboard is now in \texttt{ALPHA-LOCK}.) Type \texttt{ROLLS} as the name of the program, and press \texttt{ENTER}. You are now in the program editor. The : (colon) in the first column of the second line indicates that this is the beginning of a command line.

3. Press \texttt{PRGM \{ \}} to access the \texttt{PRGM I/O} menu. Press 4. \texttt{CLRHOME} is copied to cursor location. Press \texttt{ENTER} to complete the instruction and move to the next line.

4. Press 0 \texttt{[STO] \{ 2nd \} LIST 3 \{ 2nd \} [L1]. This sets the dimension of \texttt{L1} (the list where the results of the rolls will be stored) to 0. Press \texttt{ENTER} to complete the instruction and move to the next line.

5. Press \texttt{PRGM \{ \}} 1 to copy \texttt{INPUT} to the cursor location. Press \texttt{2nd \{ A-LOCK \} [*] ROLLS [2nd \{ TEST \} 1 ALPHA [*] ALPHA R \{ 1 \}} to prompt the user to input the number of rolls. Press \texttt{ENTER} to complete the instruction.

6. Press \texttt{PRGM \{ \}} 4 to copy \texttt{FOR} to the cursor location. Press \texttt{ALPHA 1 \{ \} 1 \{ 2nd \} ALPHA R \{ 1 \}}. Press \texttt{ENTER} to complete the instruction.
7. Press \textbf{[Math]} \textbf{[6]} to access the \textbf{Math Prb} menu. Press \textbf{5} (to copy \texttt{RandInt} to the cursor location) \texttt{1} \texttt{6} \texttt{[Stor]} 2 \texttt{[1]} \texttt{[Alpha]} \texttt{1} to generate random integers from 1 to 6 and store them into element \texttt{I} of \texttt{L1}. Press \texttt{[Enter]} to complete the instruction.

8. Press \texttt{[Prgm]} \texttt{[2]} to select \texttt{Disp} (display), which is copied to the cursor location. Press \texttt{[2nd]} \texttt{[1]} \texttt{[Alpha]} \texttt{1} \texttt{[2]} \texttt{[3]} \texttt{[4]} \texttt{[5]}. This instruction displays the value of element \texttt{I} (the result of the last roll) in \texttt{L1}. Press \texttt{[Enter]} to complete the instruction.

9. Press \texttt{[Prgm]} \texttt{[6]} to select \texttt{Pause}, which is copied to the cursor location. This pauses the program after displaying the result of the last roll. Press \texttt{[Enter]} to complete the instruction.

10. Press \texttt{[Prgm]} \texttt{[5]} to select \texttt{End}, which is copied to the cursor location. \texttt{End} identifies the end of the group of commands in the \texttt{For} (loop. Press \texttt{[Enter]} to complete the instruction.

11. Press \texttt{[Prgm]} \texttt{[2]} \texttt{[2]} \texttt{[1]} \texttt{[2]} \texttt{[3]} to display the list of all the roll results. Press \texttt{[Enter]} to complete the instruction.

12. Press \texttt{[2nd]} \texttt{[QUIT]} \texttt{[Clear Prgm]}. Move the cursor to the program name \texttt{Roll}. Press \texttt{[Enter]}. Press \texttt{[Enter]} again from the Home screen to execute \texttt{Prgm_Roll}.
About TI-80 Programs

Most features of the TI-80 are accessible from programs. Programs can access all variables and named items. The number of programs that the TI-80 can store is limited only by available memory.

Notes about Programs

Programs are identified by names of up to seven characters, beginning with a letter.

A program consists of a series of program commands, which begin with a : (colon). A program command can be an expression (a command, usually a combination of variables, functions, and numeric values, that returns a value to ANS) or an instruction (a command, such as GRIDON or PT-ON(), that does not return a value to ANS).

The TI-80 checks for errors when you execute the program, not as you enter or edit the program.

Variables and lists saved in memory are global; that is, they can be accessed from all programs. Storing a new value to a variable or list in a program changes the value in memory during program execution.

As calculations are made in programs, the TI-80 updates ANS, just as it would if the calculations were done on the Home screen. Programs do not update Last Entry as each command is executed.

"Breaking" a Program

Pressing \( \text{ON} \) stops program execution. When you press \( \text{ON} \) during program execution, the ERR: BREAK menu is displayed.

- To go to where the interruption occurred, select GOTO.
- To return to the Home screen, select QUIT.

Memory Management and Erasing Programs

The size of programs you can store is limited only by available memory. To access the MEMORY menu, press \( \text{MEM} \) from the Home screen. Memory status is displayed on the MEMORY CHECK RAM... screen. To increase available memory, you can delete items, including other programs, from the MEMORY DELETE... screen (Chapter 12).

Note: Each token in a program takes 1 byte. For example, SIN 1.23 takes 5 bytes.
Creating and Executing Programs

Access the program editor by pressing \[\text{PRGM}\]. Then either choose to create a new program or edit an existing program. In general, anything that can be executed from the Home screen can be included in a program. A program command always begins with a colon (:).

Creating a New Program

To create a new program:

1. Press \[\text{PRGM} \rightarrow \text{PRGM NEW}\] to display the \text{PRGM NEW} menu. Press \[\text{ENTER}\] to select \text{CREATE NEW}.

\[
\begin{array}{|c|}
\hline
\text{PROGRAM NAME=F} \\
\hline
\end{array}
\]

2. The keyboard is in \text{ALPHA-LOCK}. Enter the name you want for the program, followed by \[\text{ENTER}\]. The name may have one to seven characters (A–Z, 0–9) and must begin with a letter.

3. Enter the program commands.

Entering Program Commands

A colon (:) indicates the beginning of each program command.

To enter more than one command on a line, separate them with a colon, just as you would on the Home screen. Press \[\text{ENTER}\] to indicate the end of a command line.

When a command is longer than one line on the screen, it wraps to the next line. \[\text{2nd} \rightarrow \text{A} \text{ or } \text{2nd} \rightarrow \text{B}\] move the cursor to the beginning and end of a command line.

In the program editor, if you press a key that accesses a menu, the menu screen temporarily replaces the program edit screen. When you make a selection or press \[\text{CLEAR}\], you are returned to the program editor.

Leaving the Program Editor

When you finish entering or editing a program, press \[\text{2nd} \rightarrow \text{QUIT}\] to return to the Home screen. You must be on the Home screen to execute a program.

Executing a Program

To execute a program:

1. From a blank line on the Home screen, press \[\text{PRGM}\] to display the \text{PRGM EXEC} menu. The names of all existing programs are listed in alphabetical order.

2. Select the program. \text{PRGM} and the program name are copied to the Home screen; for example, \text{PRGM ROLL}.

3. Press \[\text{ENTER}\] to begin program execution. While the program is executing, the busy indicator is displayed.
The program editor also lets you edit an existing program. As you edit, you can enter commands just as you did when you created the program.

To edit a program:

1. Press \( \text{PRGM} \) \( \boxed{9} \) to display the PRGM EDIT menu.

2. Select the name of an existing program. The program editor and the commands in that program are displayed.

3. Edit the program by changing, inserting, or deleting commands, as needed.

   Move the cursor to the command you want to change.

   • Position the cursor, and then make the changes by typing over the command or using \( \text{DEL} \) or \( \boxed{2nd} \) \( \text{Ins} \).

   • Press \( \text{CLEAR} \) to clear (blank) all program commands on the command line (The leading colon is not deleted.), and then enter a new program command.

To insert a new command line, position the cursor where you want to insert the new line, press \( \boxed{2nd} \) \( \text{Ins} \) to put the TI-80 in insert mode, and then press \( \text{ENTER} \).

To delete a command line, press \( \text{CLEAR} \) to clear the line, and then press \( \text{DEL} \) to delete the colon.

Note: All programs end with a blank command line; the colon on this line cannot be deleted.
PRGM CTL (Control) Instructions

PRGM CTL (program control) instructions are accessed only from within the program editor. They direct the flow within an executing program, making it easy to repeat or skip commands during program execution. While the program editor is displayed, press [PRGM]. The selected menu item is copied to the cursor location.

PRGM CTL Menu

<table>
<thead>
<tr>
<th>CTL I/O EXEC</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: IF</td>
<td>Creates a conditional test.</td>
</tr>
<tr>
<td>2: THEN</td>
<td>Used with IF-THEN.</td>
</tr>
<tr>
<td>3: ELSE</td>
<td>Used with IF-THEN.</td>
</tr>
<tr>
<td>4: FOR()</td>
<td>Creates incrementing loop.</td>
</tr>
<tr>
<td>5: END</td>
<td>Signifies end of loop, IF-THEN, or ELSE.</td>
</tr>
<tr>
<td>6: PAUSE</td>
<td>Pauses program execution.</td>
</tr>
<tr>
<td>7: LBL</td>
<td>Defines a label.</td>
</tr>
<tr>
<td>8: GOTO</td>
<td>Goes to a label.</td>
</tr>
<tr>
<td>9: PRGM_</td>
<td>Executes a program as a subroutine.</td>
</tr>
<tr>
<td>0: RETURN</td>
<td>Returns from a subroutine.</td>
</tr>
<tr>
<td>A: STOP</td>
<td>Stops program execution.</td>
</tr>
</tbody>
</table>

Controlling Program Flow

Program control instructions tell the TI-80 which command to execute next in a program. IF checks a condition that you define to determine what command to execute next. The condition frequently uses relational tests (Chapter 2), such as IF \(A < 7: A + 1 \rightarrow A\).

IF

IF (PRGM CTL, item 1) is used for testing and branching. If the condition is false (zero), the command immediately following IF is skipped. If the condition is true (nonzero), that command is executed. IF instructions can be nested.

: IF condition
: command if true
: command

Programming 10-7
THEN (PRGM CTL, item 2) following an IF executes a group of commands if the condition is true (nonzero).

END (PRGM CTL, item 5) identifies the end of the group.

:IF condition
:THEN
:command if true
:...
:END
:command

ELSE (PRGM CTL, item 3) following IF-THEN executes a group of commands if the condition is false (zero).

END (PRGM CTL, item 5) identifies the end of the group.

:IF condition
:THEN
:command if true
:...
:ELSE
:command if false
:...
:END
:command
FOR( (PRGM CTL, item 4) is used for looping and incrementing. It increments the variable from the beginning value to the ending value, by the specified increment. The ending value is a maximum or minimum value that is not to be exceeded. The increment is optional (if not specified, 1 is used) and can be negative (ending value < beginning value).

END identifies the end of the loop. FOR( loops can be nested.

:FOR(variable, begin, end, increment)
:command while end not exceeded
:...
:END
:command

END (PRGM CTL, item 5) identifies the end of a group of commands. Each FOR( and each IF-THEN or IF-THEN-ELSE group must have an END at the “bottom.”

PAUSE (PRGM CTL, item 6) suspends execution of the program so that you can see answers or graphs. During the pause, the dotted pause indicator is displayed. When DISP or DISPGRAPH is executed, the appropriate screen is displayed. Press [ENTER] to resume program execution.
LBL (label) and GOTO (go to) are used together for branching.

LBL (PRGM CTL, item 7) gives a label to a command line in a program. The label is one character (A–Z, 0–9, or 0).

LBL label

GOTO (PRGM CTL, item 8) causes the program to branch to the command line with the same label.

GOTO label

PRGM_ (PRGM CTL, item 9) calls (executes) other programs as subroutines (pages 10-14). When you select PRGM_, it is copied to the cursor location. You may type the letters of an existing program name. You may also enter the name of a program you have not yet created.

When encountered, the command executes the specified program and then returns to the calling program. Execution continues with the command following PRGM_programname.

PRGM_programname

RETURN (PRGM CTL, item 0) quits the subroutine and returns to the calling program (pages 10-14), even if it is encountered within nested loops. (Any loops are ended.) There is an implied RETURN at the end of any program called as a subroutine. Within the main program, RETURN stops program execution and returns to the Home screen.

STOP (PRGM CTL, item A) stops execution of a program and returns you to the Home screen. STOP is optional at the end of a program. There is an implied stop at the end of the main program that is being executed.

10-10  Programming
The PRGM I/O (program input/output) instructions are accessed only from the program editor. They control input to and output from a program, allowing you to enter values and display answers during program execution. While the program editor is displayed, press PRGM. The selected menu item is copied to the cursor location.

### PRGM I/O Menu

<table>
<thead>
<tr>
<th>CTL I/O EXEC</th>
<th>1: INPUT</th>
<th>Enters a value or displays the current graph.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2: DISP</td>
<td>Displays text, value, or the Home screen.</td>
<td></td>
</tr>
<tr>
<td>3: DISPGRAPH</td>
<td>Displays the current graph.</td>
<td></td>
</tr>
<tr>
<td>4: CLRHOME</td>
<td>Clears the Home screen.</td>
<td></td>
</tr>
</tbody>
</table>

### Displaying a Graph with INPUT

INPUT without a variable displays the current graph. You can move the free-moving cursor, which updates X and Y. The dotted pause indicator is displayed. Press ENTER to resume program execution.

For example, INPUT during program execution displays:

```
PRGMSInputs
1: INPUT
2: DISP
3: DISPGRAPH
```

```
X=0
Y=0
```
**Storing a Variable Value with INPUT**

INPUT with a variable displays a ? prompt during program execution. The value for the variable may be a real number, a list, or \( Y=\) function. During program execution, enter a value (a real number, an expression, or a list), and press [ENTER]. The value is evaluated and stored to the variable, listname, or \( Y=\) function, and the program resumes execution.

**INPUT** variable
**INPUT** listname
**INPUT** \( Y=\)name

You can enter a string of up to 16 characters to prompt for the value to be entered. During program execution, enter a value, and press [ENTER] after the prompt. The value is stored to the variable, listname, or \( Y=\) function, and the program resumes execution.

**INPUT** "text",variable
**INPUT** "text",listname
**INPUT** "text",\( Y=\)name

Note: When you input lists and expressions during program execution, you must include the braces (\( \{ \) ) around the list elements and quotation marks ("\( \)\( \) ) around expressions.
Displaying the Home Screen

**DISP** (display, PRGM I/O, item 2) with no value displays the Home screen. To view the Home screen during program execution, follow the **DISP** instruction with a **PAUSE**.

Displaying Values and Messages

**DISP** (display, PRGM I/O, item 2) with one or more values displays the value of each.

**DISP value**

If **value** is a variable, the current value is displayed.

If **value** is an expression, it is evaluated and then displayed, according to the current mode settings, on the right of the following line.

If **value** is text within " marks, it displays on the left of the current display line.

For example, **DISP "ANSWER IS",π/2** displays:

- If **PAUSE** is encountered after **DISP**, the program halts temporarily so that you can examine the screen. Press **[ENTER]** to resume program execution.

**Note:** A statement that results in a value will display without using **DISP**, if it is the last statement (other than **STOP**, **END**, and **PAUSE**) in the program.

**DISPGRAPH**

**DISPGRAPH** (display graph, PRGM I/O, item 3) displays the current graph. If **PAUSE** is encountered after **DISPGRAPH**, the program halts temporarily so you can examine the screen. Press **[ENTER]** to resume execution.

**CLRHOME**

**CLRHOME** (clear Home screen, PRGM I/O, item 4) clears the Home screen during execution and places the cursor in the upper left corner; however, program execution does not pause unless **PAUSE** is encountered.
Calling Other Programs

On the TI-80, any program can be called from another program as a subroutine. Enter the name of the program to use as a subroutine on a line by itself.

Calling a Program from Another Program

To call one program from another, begin on a blank line in the program editor and do one of the following.

- Press [PRGM] to display the PRGM EXEC menu, and select the name of the program. PRGM_ and the name are copied to the cursor location.
- Select PRGM_ from the PRGM CTL menu and then type the letters of the programname.

PRGM_programname

When this instruction is encountered during program execution, the next command that the program executes is the first command in the second program. Execution continues with the subsequent command in the first program when it encounters either a RETURN instruction or when the implied RETURN at the end of the called program is encountered.

Variables are global.

A label used with GOTO and LBL is local to the program in which it is located. A label in one program is not “known” by another program. You cannot use GOTO to branch to a label in another program.

RETURN exits a subroutine and returns to the calling program, even if encountered within nested loops.
# Chapter 11: Applications

This chapter contains application examples that incorporate the TI-80 features described in the preceding chapters. Several of the examples use programs.

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<td>Program: Newton's Numerical Solve Routine</td>
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Probability Experiments: Coins, Dice, and Spinners

The RANDINT( (random integer) function can be used for probability experiments. RANDINT( takes two arguments that define a set of integers from which to draw for the probability experiments below.

**Problem**

Using RANDINT( from the MATH PRB menu, devise probability experiments that employ the toss of a coin, the roll of two dice, and the spin of a wheel.

**Procedure**

For the coin tossing experiment, enter RANDINT(0,1) from the Home screen. 0 = tails and 1 = heads. Press ENTER repeatedly to generate the coin tosses.

You can also write a simple program to display “heads” or “tails” for each coin toss.

```
PROGRAM COIN
PRGM COIN
:RANDINT(0,1)→R
:IF R=0 THEN
:DISP "TAILS"
:ELSE
:DISP "HEADS"
:END
```

You can simulate the rolling of two dice by adding together the result from each die after a roll. On the Home screen, enter RANDINT(1,6)+RANDINT(1,6) and press ENTER repeatedly.

You can simulate spinning a wheel with the numbers 1 to 100 using the RANDINT( function. Enter RANDINT(1,100) on the Home screen and press ENTER repeatedly.
The Unit Circle and Trigonometric Curves

You can use the parametric graphing feature of the TI-80 to show the relationship between the unit circle and any trigonometric curve.

**Problem**
Graph the unit circle and the sine curve to demonstrate graphically the relationship between them.

Any function that can be plotted in function graphing can be plotted in parametric graphing by defining the X component as T and the Y component as F(T).

**Procedure**
Following this procedure to solve the problem.

1. Press **MODE** and select **RADIAN, PARAM, and SIMUL**.
2. Press **WINDOW** and set the Window variables.
   - TMIN = 0
   - XMIN = -2
   - YMIN = -3
   - TMAX = 2π
   - XMAX = 2π
   - YMAX = 3
   - TSTEP = .1
   - XSCL = π/2
   - YSCL = 1
3. Press **Y=** and enter the expressions to define the unit circle centered at (1,0).
   - X1T=COS T-1
   - Y1T=SIN T
   Enter the expressions to define the sine curve.
   - X2T=T
   - Y2T=SIN T
   Turn off all other functions.

4. Press **GRAPH** to see the SIN function “unwrap” from the unit circle.

**Note:** The “unwrapping” can be generalized. Replace SIN T in Y2T with any other trig function to “unwrap” that function.
Program: Newton’s Numerical Solve Routine

This program uses the Newton-Raphson method to find the roots (zeros) of a function numerically.

Problem
Find the roots of $e^x - 3x$.

Program
This program uses the Newton-Raphson method to find a root of $Y_1$ based on an initial guess. The program prompts for the initial guess. One way to make this initial guess is to graph and trace the function, and then enter $X$ as the guess.

```
PROGRAM:NEWTON
:INPUT "INITIAL X=",X Input initial guess.
:LBL N Begin loop.
:R->X
:Y1/NDERIV(Y1,X,X)→R Calculate new root.
:DISP R
:PAUSE
:IF ABS (X-R)≤ABS (X/10) Test for convergence.
:STOP
:R→X Estimate with new root.
:GOTO N
```

Procedure
Follow this procedure to solve the problem.

1. Press MODE and select FUNC.
2. Enter the program.
3. Press Y= and enter the expression $e^x - 3x$ to define $Y_1$.

```
Y1=ECX-3X
```

4. Graph the function using ZDECPM from the ZOOM menu.
5. Press \texttt{TRACE} and move the cursor close to the left root. The variables $X$ and $Y$ are updated as you move the cursor.

\begin{center}
\begin{tabular}{c}
$X$: 5 \\
$Y$: 0.2312 \\
\end{tabular}
\end{center}

6. From a blank line on the Home screen, execute the program \texttt{NEWTON}.

7. Enter $X$ as the initial guess, and press \texttt{ENTER} repeatedly. The program stops when the relative difference between the new root estimate and the previous root estimate is less than $X \times 10$.

\begin{center}
\texttt{PRGM.NEWTON} \\
\texttt{INITIAL.X:} \\
\texttt{8197784694} \\
\texttt{8197784815} \\
\texttt{8197784897} \\
\texttt{8197784897} \\
\texttt{DONE}
\end{center}

8. When program execution is complete, evaluate the function at the estimated root.

\begin{center}
$Y(X)$
\end{center}

Repeat the steps in this procedure to find the other root.
Program: Numerical Integration

This program uses Simpson’s method to estimate the definite integral of a function.

**Problem**

Estimate the definite integral of

\[ \int_{0}^{1.5} (6-6x^5) \, dx \]

and graph the area of the integral.

**Program**

The program estimates the definite integral for \( Y1 \) using Simpson’s method. It prompts for the lower and upper limits of integration and the number of divisions.

**PROGRAM:** SIMPSON

```
:INPUT "LOWER LIMIT=", A
:INPUT "UPPER LIMIT=", B
:INPUT "N DIVISIONS=", D
:0 \( \rightarrow \) S
:(B \( \rightarrow \) A)/(2 \( \times \) D) \( \rightarrow \) W
:FOR(J,1,D,1)
:B+2(J-1)W \( \rightarrow \) L
:B+2JW \( \rightarrow \) R
:(L+R)/2 \( \rightarrow \) M
:W(Y1(L)+4Y1(M)+Y1(R)) \( \rightarrow \) S
-END
:DISP "AREA="
:DISP S
```

**Procedure**

Follow this procedure to solve the problem.

1. Enter the program.

2. Press \( \boxed{Y} \) and enter the function in \( Y1 \). Turn any other functions off.

\[
Y_1 = 6x - 6x^5
Y_2 = Y_3 = Y_4 =
\]
3. Set the Window variables.

```
WINDOW
XMIN=-1
XMAX=3
XSCAL=1
YMIN=-10
YMAX=10
YSCAL=1
```

4. Execute the program **SIMPSON** from a clear Home screen, entering the limits and divisions as you are prompted.

```
PRGM.SIMPSON
LOWER LIMIT=0
UPPER LIMIT=1.5
N DIVISIONS=30
AREA=2.390626758
DONE
```

5. You can display the calculated area graphically, using **SHADE** from a clear Home screen.

```
SHADECMP(0<y<1.5,
MIN(0,y>1.5,x>1))
```
The program below lets you store the values for the current Window variables, and it lets you display a graph using previously stored values. It also demonstrates a method for including menus in a program.

**Program: Window Variables Store and Recall**

The program below lets you store the values for the current Window variables, and it lets you display a graph using previously stored values. It also demonstrates a method for including menus in a program.

**Program**

PROGRAM: WINMEM
: CLRHOME
: DISP "WINDOW MEMORY"
: DISP "1:STORE WINDOW"
: DISP "2:RECALL WINDOW"
: DISP "3:QUIT"
: DISP "*"
: DISP "ENTER 1, 2, OR 3"
: INPUT M
: IF M=1
: GOTO S
: IF M=2
: GOTO R
: GOTO Q
: LBL S
: A→XMIN
: B→XMAX
: C→XSCL
: D→YMIN
: E→YMAX
: F→YSCL
: DISP "WINDOW STORED"
: GOTO Q
: LBL R
: XMIN→A
: XMAX→B
: XSCL→C
: YMIN→D
: YMAX→E
: YSCL→F
: DISP "WINDOW STORED"
: GOTO Q
: LBL Q
: STOP

Present menu of choices.
Evaluate menu selection.
Store current graph Window variable values.
Display graph with previously stored variable values.
Quit program.
Follow this procedure to see how the program works.

1. Execute the program `WINMEM` from a blank Home screen.

   \[
   
   \text{PRGM.WINMEM}
   
   \]

   The program prompts with three options.
   - Store the Window variables you are currently using.
   - View a graph using a previously stored set of Window variables.
   - Quit the program.

   \[
   \text{WINDOW MEMORY}
   \text{1:STORE WINDOW}
   \text{2:RECALL WINDOW}
   \text{3:QUIT}
   \text{ENTER 1, 2, OR 3}
   \]

2. Press 1, 2, or 3 and then enter to respond to the prompts.

   The Window values are stored in variables A, B, C, D, E, and F.
Graphing the Inverse of a Function

You can use the parametric graphing feature of the TI-80 to graph the inverse relation of any function by defining the function in \( X_1T \) and \( Y_1T \) and its inverse in \( X_2T \) and \( Y_2T \).

**Problem**

The function \( Y = 0.2X^3 - 2X + 6 \) can be expressed in parametric form as \( X_1T = T \) and \( Y_1T = 0.2T^3 - 2T + 6 \).

The inverse relation of the function can be expressed in parametric form as \( X_2T = F(T) \) and \( Y_2T = T \). For example, \( Y = 2X^3 - 2X + 6 \) would be expressed as \( X_2T = 0.2T^3 - 2T + 6 \) and \( Y_2T = T \).

Graph the function \( Y = 2X^3 - 2X + 6 \) and its inverse.

**Procedure**

Follow this procedure to solve the problem.

1. Select **Param**, **CONNECTED**, and **Simul** modes.

2. Change the Window variable values.

   \[
   \begin{align*}
   Tmin &= 10 & Xmin &= 15 & Ymin &= 9 \\
   Tmax &= 10 & Xmax &= 15 & Ymax &= 9 \\
   Tstep &= 0.4 & Xscl &= 1 & Yscl &= 5
   \end{align*}
   \]

3. Enter the expressions to define the function in parametric form.

   \[
   \begin{align*}
   X_1T &= T \\
   Y_1T &= 0.2T^3 - 2T + 6
   \end{align*}
   \]

4. Enter the expressions to define the inverse in parametric form.

   \[
   \begin{align*}
   X_2T &= 0.2T^3 - 2T + 6 \\
   Y_2T &= T
   \end{align*}
   \]
5. Enter the expressions to define the line $Y=X$, about which the graph of the function and the graph of its inverse are symmetric. That is, the reflection of the graph of the function through the line $Y=X$ produces the graph of its inverse.

\[
X_3 = T \\
Y_3 = T
\]

6. Press [GRAPH] to plot the graph. Press [TRACE], and then press ▼ several times (until the cursor appears). Next, press ▼ and ▲ several times to move the cursor from a point on the relation to the reflected point and back again.

**Note:** The expressions to define the inverse can be generalized.

\[
X_1 = Y_2 \\
Y_1 = X_2
\]
The test functions of the TI-80 can be used to build piecewise defined functions.

**Problem**

Define and graph this piecewise defined function.

\[
f(x) = \begin{cases} 
  x^2, & \text{for } x \leq 3 \\
  1.5x + 1, & \text{for } 3 < x < 5 \\
  6 - x, & \text{for } x \geq 5 
\end{cases}
\]

The TEST functions, which return 1 if true and 0 if false, can be used to build piecewise defined functions. For example, when \( x \) is 4 (\( x \leq 3 \)) is false and will return 0.

**Procedure**

Follow this procedure to solve the problem.

1. Press \( \boxed{MODE} \) and select \( \boxed{FUNC} \).
2. Enter the first piece of the function in the \( Y= \) editor. This piece is \( f(x) = x^2 \) for \( x \leq 3 \). It is entered as \( y_1(x) = x^2 \cdot (x \leq 3) \). \( y_1 \) is then equivalent to \( x^2 \cdot 1 \) for \( x \leq 3 \) and \( x^2 \cdot 0 \) for \( x > 3 \).
3. Add the second piece of the function in the \( Y= \) editor. This piece is \( f(x) = 1.5x + 1 \) for \( 3 < x < 5 \). It is entered as \( y_1(x) = (1.5x + 1) \cdot (3 < x) \cdot (x < 5) \).

When \( x \) is less than 3, the test \( (3 < x) \) returns 0, and the test \( (x < 5) \) returns 1. In this case, the second piece of the function is equivalent to \( (1.5x + 1) \cdot 0 \cdot 1 \), which is 0. Only when both of these tests are true will the second piece of this function be anything but 0.
4. Add the third piece of the function to Y1. This piece is $f(x) = 6 - x$ for $x \geq 5$. It is entered as $(6-x)(x \geq 5)$. When $x$ is greater than or equal to 5, the test $(x \geq 5)$ returns 1. The third piece of the function is then equivalent to $(6-x) \cdot 1$. When $x$ is less than 5, the test $(x \geq 5)$ returns 0. The third piece of the function is then equivalent to $(6-x) \cdot 0$.

5. Enter these Window variable values.

<table>
<thead>
<tr>
<th>Xmin</th>
<th>Ymin</th>
<th>Xmax</th>
<th>Ymax</th>
<th>Xscl</th>
<th>Yscl</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>-2</td>
<td>8</td>
<td>10</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

6. Graph the piecewise function first in CONNECTED and then DOT mode. Select CONNECTED on the MODE screen, and then press [GRAPH]. Then select DOT on the MODE screen, and press [GRAPH].
Graphing Inequalities

Examine the inequality \(0.4X^3 - 3X + 5 < 0.2X + 4\) graphically. Use the TEST functions to explore the values of \(X\) where the inequality is true and where it is false.

Procedure

1. Press \(\boxed{MODE}\). Select \(\boxed{DOT, SIMUL}\), and the default mode settings. Press \(\boxed{2ND STAT PLOT}\), and turn off all stat plots.

2. Press \(\boxed{Y=}\), and turn off all functions. Enter the left side of the inequality as \(Y_1\), the right side as \(Y_2\), and the statement of the inequality as \(Y_3\). \(Y_3\) evaluates to 1 if true and 0 if false.

3. Press \(\boxed{WINDOW}\), and enter these Window variable values.
   
   \[
   \begin{align*}
   \text{Xmin} &= -10 & \text{Ymin} &= -10 \\
   \text{Xmax} &= 10 & \text{Ymax} &= 10 \\
   \text{Xscl} &= 5 & \text{Yscl} &= 5
   \end{align*}
   \]

4. Press \(\boxed{TRACE}\). Press \(\boxed{\leftarrow}\) or \(\boxed{\rightarrow}\) to move to \(Y_3\). Trace the inequality, observing the value of \(X\). \(Y_3\) is 1 when \(Y_1 < Y_2\), and \(Y_3\) is 0 when \(Y_1 \geq Y_2\).

5. Press \(\boxed{Y=}\) and turn off \(Y_1\) and \(Y_2\). Enter equations to graph only the inequality.

6. Press \(\boxed{TRACE}\). Notice that the values of \(Y_3\) and \(Y_4\) are zero where the inequality is false.
The parametric graphing feature of the TI-80 can be used to graph polar equations. Graph the Spiral of Archimedes, the name given to the curve defined by the polar equation r=a \theta.

Problem
A polar equation r=f(\theta) can be graphed by applying the conversion formulas, x=f(\theta) \cos(\theta) and y=f(\theta) \sin(\theta). Thus, the Spiral of Archimedes can be expressed parametrically as:

\[x = \frac{1}{2} \theta \cos(\theta)\]
\[y = \frac{1}{2} \theta \sin(\theta)\]

Follow this procedure to solve the problem.

1. Select PARAM mode. Choose the defaults for the other mode settings.

2. Enter the expressions to define the parametric equation in terms of T.

\[
\begin{align*}
x &= \frac{1}{2} \theta \cos(\theta) \\
y &= \frac{1}{2} \theta \sin(\theta)
\end{align*}
\]

3. Set the Window variables to the following values.

\[
\begin{align*}
T_{\text{min}} &= 0 & X_{\text{min}} &= 10 & Y_{\text{min}} &= 10 \\
T_{\text{max}} &= 25 & X_{\text{max}} &= 10 & Y_{\text{max}} &= 10 \\
T_{\text{step}} &= \pi & X_{\text{scl}} &= 1 & Y_{\text{scl}} &= 1
\end{align*}
\]

4. Press [GRAPH] to display the Spiral of Archimedes.
Program: Guess the Coefficients

This program generates a function in the form $A\cdot \sin(BX)$ with random integer coefficients between 1 and 10. Seven data points from the function are plotted. You are prompted to guess the coefficients, which are plotted as $C\cdot \sin(DX)$. The program continues until your guess is correct. It can be modified for other functions.

Program

```
PROGRAM: GUESS
:FUNC: RADIUS
:-31(\pi/12)→XMIN
31(\pi/12)→XMAX
\pi/2→XSCAL
-10→YMIN
10→YMAX
1→YSCAL
:"A\cdot \sin (BX)"→Y1
RANDINT(1,10)→A
RANDINT(1,10)→B
: PLOTS OFF: FNOFF
: DISGRAPH
: SEQ(XMIN+I \cdot DX,I,0,62,9)→L1
: Y1(L1)→L2
: PLOT1(L1,L2,\ldots)
: DISGRAPH
: PAUSE
:"C\cdot \sin (DX)"→Y2
:LBL W
: CLRHOME
: DISP "C\cdot \sin (DX)"
: INPUT "C=",C
: INPUT "D=",D
: DISGRAPH
: PAUSE
: IF C=A
: DISP "C IS OK"
: IF C>A
: DISP "C IS TOO HIGH"
: IF C<A
: DISP "C IS TOO LOW"
: IF D=B
: DISP "D IS OK"
: IF D>B
: DISP "D IS TOO HIGH"
: IF D<B
: DISP "D IS TOO LOW"
: PAUSE
: IF((C=A)\&(D=B))=1
: STOP
: GOTO W
```

Set viewing window.

Initialize coefficients.

Display data points.

Prompt for guesses.

Display results.

Quit if guesses are correct.
Chapter 12: Memory Management

This chapter describes how to manage memory on the TI-80. To increase the amount of memory available for use, occasionally you may want to delete stored items that you are no longer using. You can also reset the calculator, erasing all data and programs.

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<td>12-3</td>
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<tr>
<td>Resetting the TI-80</td>
<td>12-4</td>
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</table>
Checking Available Memory

The MEMORY CHECK RAM screen displays the total amount of available memory and the amount of memory used by each variable type. This allows you to determine the amount of memory available for new items such as programs and the amount used by old items that you no longer need.

To check the amounts of available and used memory:

1. Press [MEM] to display the MEMORY menu.

2. Press 1 or [ENTER] to select CHECK RAM....

   ![MEMORY CHECK RAM screen]

   The amount of available memory and the number of bytes used by each variable type are shown on the right.

3. To leave the CHECK RAM display:
   - Press [QUIT] to go to the Home screen.
   - Press [MEM] to return to the MEMORY menu.
Deleting Items from Memory

You can delete the contents of any variable (real number, list, or Y= function) or program from memory to increase available memory.

Deleting an Item

To delete an item:

1. Press [2nd] [MEM] to display the MEMORY menu.

2. Press 2 to select DELETE... A screen showing all variables currently in use and the amount of memory used by each is displayed.

```
DELETES
P:INES   14
L1       13
Y1       17
Y2       14
```

The file names are listed in the following order:

- Program names
- List names
- Y= equation names
- Numeric variable names

3. Use [4] and [8] to position the cursor, which is indicated by ▶ in the left column, next to the item you want to delete; and press [ENTER]. The item is deleted immediately.

You can continue to delete individual items from this screen. To leave the DELETE display:

- Press [2nd] [QUIT] to go to the Home screen.
- Press [2nd] [MEM] to return to the MEMORY menu.

Note: Some system variables—such as REGEQ, for example—cannot be deleted. These system variables are not shown on the DELETE display.
Resetting the TI-80

Resetting the TI-80 restores memory to the factory settings, including deleting the contents of all variables and programs and resetting all system variables to the original settings. Because you can increase available memory by deleting individual items, you should rarely need to reset the TI-80.

**Resetting**

To reset the TI-80:

1. Press \( \text{\textasciitilde} \text{MEM} \) to display the MEMORY menu.
2. Press 3 to select **RESET**....

3. Make the appropriate menu selection:
   - To go to the Home screen without resetting memory, select **NO**.
   - To reset memory, select **RESET**. The Home screen is displayed with the message **MEM CLEARED**.

**Note:** If the screen is blank after **RESET**, adjust the display contrast. Press \( \text{\textasciitilde} \text{MEM} \) and then press and hold \( \text{\textasciitilde} \) (to make the display darker) or \( \text{\textasciitilde} \) (to make the display lighter). You can press **CLEAR** to clear the message on the display.
# Appendix A: Tables and Reference Information

This appendix provides a list of all TI-80 functions that you can use in expressions and instructions that you can use on the Home screen and in programs. It also includes other reference information that can help you.

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</table>
**Table of TI-80 Functions and Instructions**

A function (F) returns a value or a list and can be used in expressions; an instruction (I) initiates an action. Some, but not all, have arguments. † indicates that the instruction is available for copying only from the program editor.

<table>
<thead>
<tr>
<th>Function/Command</th>
<th>Description</th>
<th>Arguments</th>
<th>Page</th>
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</thead>
<tbody>
<tr>
<td><code>a_b/c</code></td>
<td>Sets the display format for fraction results to <code>a_b/c</code> (mixed fraction) mode.</td>
<td>(I)</td>
<td>1-11</td>
</tr>
<tr>
<td><code>value_a_b/c</code></td>
<td>Returns <code>value</code> as a mixed fraction.</td>
<td>(F)</td>
<td>3-9</td>
</tr>
<tr>
<td><code>ABS value</code></td>
<td>Returns the absolute value of <code>value</code>.</td>
<td>(F)</td>
<td>2-6</td>
</tr>
<tr>
<td><code>ABS list</code></td>
<td>Returns a list of absolute values for each element in <code>list</code>.</td>
<td>(F)</td>
<td>2-6</td>
</tr>
<tr>
<td>Addition: <code>value</code>+<code>valueB</code></td>
<td>Returns <code>valueA</code> plus <code>valueB</code>.</td>
<td>(F)</td>
<td>2-4</td>
</tr>
<tr>
<td>Addition: <code>value</code>+<code>list</code></td>
<td>Returns a list in which <code>value</code> is added to each <code>list</code> element.</td>
<td>(F)</td>
<td>2-4</td>
</tr>
<tr>
<td>Addition: <code>listA</code>+<code>listB</code></td>
<td>Returns a list of <code>listA</code> elements plus <code>listB</code> elements.</td>
<td>(F)</td>
<td>2-4</td>
</tr>
<tr>
<td><code>AUTOSIMP</code></td>
<td>Turns on automatic simplification mode for fractions.</td>
<td>(I)</td>
<td>1-11</td>
</tr>
<tr>
<td><code>b/c</code></td>
<td>Sets the display format for fraction results to <code>b/c</code> (simple fraction) mode.</td>
<td>(I)</td>
<td>1-11</td>
</tr>
<tr>
<td><code>value_b/c</code></td>
<td>Returns <code>value</code> as a simple fraction.</td>
<td>(F)</td>
<td>3-9</td>
</tr>
<tr>
<td><code>CLRDRAW</code></td>
<td>Deletes all drawn elements from a graph or drawing.</td>
<td>(I)</td>
<td>7-12</td>
</tr>
<tr>
<td><code>CLRHOME</code></td>
<td>Clears the Home screen.</td>
<td>(I)</td>
<td>7-12</td>
</tr>
<tr>
<td><code>CLRLIST</code></td>
<td>Deletes <code>listnameA,listnameB,...</code></td>
<td>(I)</td>
<td>9-13</td>
</tr>
</tbody>
</table>

A-2 Tables and Reference Information
<table>
<thead>
<tr>
<th>CONNECTED</th>
<th>Sets connected line graphing format. (I)</th>
<th>† MODE (CONNECTED)</th>
<th>1-11</th>
</tr>
</thead>
<tbody>
<tr>
<td>COS value</td>
<td>Returns the cosine of value. (F)</td>
<td>COS</td>
<td>2-4</td>
</tr>
<tr>
<td>COS list</td>
<td>Returns a list of the cosine for each list element. (F)</td>
<td>COS</td>
<td>2-4</td>
</tr>
<tr>
<td>COS⁻¹ value</td>
<td>Returns the arccosine of value. (F)</td>
<td>2nd COS⁻¹</td>
<td>2-4</td>
</tr>
<tr>
<td>COS⁻¹ list</td>
<td>Returns a list of the arccosine for each list element. (F)</td>
<td>2nd COS⁻¹</td>
<td>2-4</td>
</tr>
<tr>
<td>Cube: value $^\varepsilon$</td>
<td>Returns the cube of value. (F)</td>
<td>MATH $^\varepsilon$</td>
<td>2-8</td>
</tr>
<tr>
<td>Cube: list $^\varepsilon$</td>
<td>Returns a list of the cube for each list element. (F)</td>
<td>MATH $^\varepsilon$</td>
<td>2-8</td>
</tr>
<tr>
<td>Cube Root: $^\sqrt[3]{}value$</td>
<td>Returns the cube root of value. (F)</td>
<td>MATH $^\sqrt[3]{}$</td>
<td>2-8</td>
</tr>
<tr>
<td>Cube Root: $^\sqrt[3]{}list$</td>
<td>Returns a list of the cube root for each list element. (F)</td>
<td>MATH $^\sqrt[3]{}$</td>
<td>2-8</td>
</tr>
<tr>
<td>value $^\uparrow$DEC</td>
<td>Returns value in decimal form. (I)</td>
<td>MATH $^\uparrow$DEC</td>
<td>2-8</td>
</tr>
<tr>
<td>list $^\uparrow$DEC</td>
<td>Returns list in decimal form. (I)</td>
<td>MATH $^\uparrow$DEC</td>
<td>2-8</td>
</tr>
<tr>
<td>DEGREE</td>
<td>Sets degree mode. (I)</td>
<td>† MODE (DEGREE)</td>
<td>1-11</td>
</tr>
<tr>
<td>Degree Notation: value $^\uparrow$</td>
<td>Interprets value as an angle in degrees. (F)</td>
<td>2nd [ANGLE] $^\uparrow$</td>
<td>2-14</td>
</tr>
<tr>
<td>DIM list</td>
<td>Returns the length of list. (F)</td>
<td>2nd [LIST] OPS (DIM)</td>
<td>8-7</td>
</tr>
<tr>
<td>length DIM listname</td>
<td>Creates (if necessary) or redimensions list to length. (I)</td>
<td>2nd [LIST] OPS (DIM)</td>
<td>8-7</td>
</tr>
<tr>
<td>DISP</td>
<td>Displays the Home screen. (I)</td>
<td>† PRGM I/O (DISP)</td>
<td>10-13</td>
</tr>
<tr>
<td>DISP &quot;text&quot;</td>
<td>Displays text. (I)</td>
<td>† PRGM I/O (DISP)</td>
<td>10-13</td>
</tr>
<tr>
<td>DISP valueA,valueB, . . .</td>
<td>Displays valueA, valueB, . . . (I)</td>
<td>† PRGM I/O (DISP)</td>
<td>10-13</td>
</tr>
<tr>
<td>DISP &quot;text&quot;,valueA, &quot;text&quot;,valueB, . . .</td>
<td>Displays text,valueA,text valueB, . . . (I)</td>
<td>† PRGM I/O (DISP)</td>
<td>10-13</td>
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</tbody>
</table>

Table: Tables and Reference Information A-3
<table>
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<tr>
<th><strong>DISPGRAPH</strong></th>
<th>Displays the current graph. (I)</th>
<th>† PRGM I/O (DISPGRAPH)</th>
<th>10-13</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Division: valueA/valueB</strong></td>
<td>Returns valueA divided by valueB. (F)</td>
<td></td>
<td>2-4</td>
</tr>
<tr>
<td><strong>Division: list/value</strong></td>
<td>Returns list elements divided by value. (F)</td>
<td></td>
<td>2-4</td>
</tr>
<tr>
<td><strong>Division: value/list</strong></td>
<td>Returns value divided by list elements. (F)</td>
<td></td>
<td>2-4</td>
</tr>
<tr>
<td><strong>Division: listA/listB</strong></td>
<td>Returns listA elements divided by listB elements. (F)</td>
<td></td>
<td>2-4</td>
</tr>
<tr>
<td><strong>DOT</strong></td>
<td>Sets dot graphing format. (I)</td>
<td>† MOD (DOT)</td>
<td>1-11</td>
</tr>
<tr>
<td><strong>DRAWF expression</strong></td>
<td>Draws expression (in X) on the current graph. (I)</td>
<td>2nd DRAW (DRAWF)</td>
<td>7-6</td>
</tr>
<tr>
<td><strong>e^power</strong></td>
<td>Returns ( e ) raised to the value of power. (F)</td>
<td>2nd ( [e^x] )</td>
<td>2-5</td>
</tr>
<tr>
<td><strong>e^list</strong></td>
<td>Returns a list of ( e ) raised to the power of each list element. (F)</td>
<td>2nd ( [e^x] )</td>
<td>2-5</td>
</tr>
<tr>
<td><strong>ELSE</strong></td>
<td>See IF-THEN-ELSE</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>END</strong></td>
<td>Identifies the end of a FOR, IF-THEN, or IF-THEN-ELSE structure. (I)</td>
<td>† PRGM CTL (END)</td>
<td>10-9</td>
</tr>
<tr>
<td><strong>Equal: valueA=valueB</strong></td>
<td>Returns 1 if valueA = valueB. Returns 0 if valueA ≠ valueB. (F)</td>
<td>2nd ( [\text{TEST}] ) (( = ))</td>
<td>2-16</td>
</tr>
<tr>
<td><strong>Equal: listA=listB</strong></td>
<td>Applies the = test to each element of listA and listB and returns a list. (F)</td>
<td>2nd ( [\text{TEST}] ) (( = ))</td>
<td>2-16</td>
</tr>
<tr>
<td><strong>Equal: list=value or value=list</strong></td>
<td>Applies the = test to each element of list and value and returns a list. (F)</td>
<td>2nd ( [\text{TEST}] ) (( = ))</td>
<td>2-16</td>
</tr>
<tr>
<td><strong>Exponent: exponent</strong></td>
<td>Returns 10 to the exponent. (F)</td>
<td>2nd ( [E^E] )</td>
<td>1-7</td>
</tr>
<tr>
<td><strong>Exponent: value exponent</strong></td>
<td>Returns value times 10 to the exponent. (F)</td>
<td>2nd ( [E^E] )</td>
<td>1-7</td>
</tr>
<tr>
<td><strong>Exponent: list exponent</strong></td>
<td>Returns list elements times 10 to the exponent. (F)</td>
<td>2nd ( [E^E] )</td>
<td>1-7</td>
</tr>
<tr>
<td>EXPREG</td>
<td>Fits Xlistname and Ylistname to the exponential model. (l)</td>
<td>STAT CALC (EXPREG)</td>
<td>9-16</td>
</tr>
<tr>
<td>----------------</td>
<td>------------------------------------------------------------</td>
<td>---------------------</td>
<td>------</td>
</tr>
<tr>
<td>EXPREG</td>
<td>Fits Xlistname and Ylistname to the exponential model with frequency freqlistname. (l)</td>
<td>STAT CALC (EXPREG)</td>
<td></td>
</tr>
<tr>
<td>Factorial: value!</td>
<td>Returns the factorial of value (0 ≤ integer ≤ 69). (F)</td>
<td>MATH PRB (!)</td>
<td>2-13</td>
</tr>
<tr>
<td>Factorial: list!</td>
<td>Returns a list containing the factorial for each list element (0 ≤ integers ≤ 69). (F)</td>
<td>MATH PRB (!)</td>
<td>2-13</td>
</tr>
<tr>
<td>FIX n</td>
<td>Sets fixed-decimal display mode for n decimal places. (l)</td>
<td>† MODE (FIX)</td>
<td>1-10</td>
</tr>
<tr>
<td>FLOAT</td>
<td>Sets floating-decimal display mode. (l)</td>
<td>† MODE (FLOAT)</td>
<td>1-10</td>
</tr>
<tr>
<td>FNOFF function#, function#, . . .</td>
<td>Deselects function#, function#, . . . (l)</td>
<td>2nd {Y-VARS} ON/OFF (FNOFF)</td>
<td>4-8</td>
</tr>
<tr>
<td>FNON function#, function#, . . .</td>
<td>Selects function#, function#, . . . (l)</td>
<td>2nd {Y-VARS} ON/OFF (FNON)</td>
<td>4-8</td>
</tr>
<tr>
<td>FOR(variable,begin,end) commands . . . :END</td>
<td>Executes commands through END, incrementing variable from begin by 1 until variable &gt; end. (l)</td>
<td>† PRGM CTL (FOR)</td>
<td>10-9</td>
</tr>
<tr>
<td>FOR(variable,begin,end, increment) commands . . . :END</td>
<td>Executes commands through END, incrementing variable from begin by increment until variable &gt; end. (l)</td>
<td>† PRGM CTL (FOR)</td>
<td>10-9</td>
</tr>
<tr>
<td>Function</td>
<td>Description</td>
<td>Mode</td>
<td>Page</td>
</tr>
<tr>
<td>--------------</td>
<td>------------------------------------------------------------------------------</td>
<td>------------</td>
<td>------</td>
</tr>
<tr>
<td>FPART value</td>
<td>Returns the fractional part of value.</td>
<td>MATH NUM</td>
<td>2-10</td>
</tr>
<tr>
<td>FPART list</td>
<td>Returns a list of the fractional parts for each list element.</td>
<td>MATH NUM</td>
<td>2-10</td>
</tr>
<tr>
<td>value&gt;FRAC</td>
<td>Returns value in fraction form, according to the current fraction display format.</td>
<td>FRAC</td>
<td>3-10</td>
</tr>
<tr>
<td>list&gt;FRAC</td>
<td>Displays list in fraction form, according to the current fraction display format.</td>
<td>FRAC</td>
<td>3-10</td>
</tr>
<tr>
<td>FUNC</td>
<td>Sets function graphing mode.</td>
<td>MODE</td>
<td>1-11</td>
</tr>
<tr>
<td>GOTO label</td>
<td>Branches the program to label.</td>
<td>PROM CTL</td>
<td>10-10</td>
</tr>
<tr>
<td>Greater Than: valueA&gt;valueB</td>
<td>Returns 1 if valueA &gt; valueB. Returns 0 if valueA ≤ valueB.</td>
<td>2nd TEST</td>
<td>2-16</td>
</tr>
<tr>
<td>Greater Than: listA&gt;listB</td>
<td>Applies the &gt; test to each element of listA and listB and returns a list.</td>
<td>2nd TEST</td>
<td>2-16</td>
</tr>
<tr>
<td>Greater Than: listA=value or value&gt;list</td>
<td>Applies the &gt; test to each element of list and value and returns a list.</td>
<td>2nd TEST</td>
<td>2-16</td>
</tr>
<tr>
<td>Greater Than or Equal: valueA=valueB</td>
<td>Returns 1 if valueA ≥ valueB. Returns 0 if valueA &lt; valueB.</td>
<td>2nd TEST</td>
<td>2-16</td>
</tr>
<tr>
<td>Greater Than or Equal: listA=listB</td>
<td>Applies the ≥ test to each element of listA and listB and returns a list.</td>
<td>2nd TEST</td>
<td>2-16</td>
</tr>
<tr>
<td>Greater Than or Equal: listA=value or value=list</td>
<td>Applies the ≥ test to each element of list and value and returns a list.</td>
<td>2nd TEST</td>
<td>2-16</td>
</tr>
<tr>
<td>GRIDOFF</td>
<td>Turns the graph grid off.</td>
<td>2nd DRAW</td>
<td>4-11</td>
</tr>
<tr>
<td>GRIDON</td>
<td>Turns the graph grid on.</td>
<td>2nd DRAW</td>
<td>4-11</td>
</tr>
</tbody>
</table>
HORIZONTAL Y'
Draws a horizontal line at value Y. (l) 28 DRAW DRAW (HORIZONTAL) 7-5

IF condition:commands
IF condition = 0 (false), skips commandsA. (l) 10-7

IF condition
THEN:commands
THEN to END if condition = 1 (true). (l) 10-8

IF condition
ELSE:commands
ELSE to END if condition = 0 (false). (l) 10-8

INPUT
Displays the current graph with the free-moving cursor. (l) 10-11

INPUT variable
Prompts for input to store to variable. (l) 10-12

INPUT "text",variable
Prompts using text and stores input to variable. (l) 10-12

INT value
Returns the largest integer ≤ value. (F) 2-10

INT list
Returns the largest integer ≤ list element. (F) 2-10

integerA INT+ integerB
Divides integerA by integerB and returns a quotient (Q) and remainder (R) on the Home screen, if there are no pending operations. (F) 2-7

listA INT+ listB
Returns a list of quotients from listA and listB. (F) 2-7

list INT+ integer or integer INT+ list
Returns list of quotients from integer and list. (F) 2-7

Inverse: value⁻¹
Returns 1 divided by value. (F) 2-4

Inverse: list⁻¹
Returns 1 divided by each list element. (F) 2-4

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<td><strong>IPART</strong> list</td>
<td>Returns a list of the integer part for each list element. (F)</td>
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<td><strong>LBL</strong> label</td>
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<td><strong>Less Than: valueA&lt;valueB</strong></td>
<td>Returns 1 if valueA &lt; valueB. Returns 0 if valueA ≥ valueB. (F)</td>
<td>2nd [TEST] (&lt;)</td>
<td>2-16</td>
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<tr>
<td><strong>Less Than: listA&lt;listB</strong></td>
<td>Applies the &lt; test to each element of listA and listB and returns a list. (F)</td>
<td>2nd [TEST] (&lt;)</td>
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<tr>
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<td>Applies the &lt; test to each element of list and value and returns a list. (F)</td>
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<tr>
<td><strong>Less Than or Equal: valueA≤valueB</strong></td>
<td>Returns 1 if valueA ≤ valueB. Returns 0 if valueA &gt; valueB. (F)</td>
<td>2nd [TEST] (≤)</td>
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<tr>
<td><strong>Less Than or Equal: listA≤listB</strong></td>
<td>Applies the ≤ test to each element of listA and listB and returns a list. (F)</td>
<td>2nd [TEST] (≤)</td>
<td>2-16</td>
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<tr>
<td><strong>Less Than or Equal: list≤value or value≤list</strong></td>
<td>Applies the ≤ test to each element of list and value and returns a list. (F)</td>
<td>2nd [TEST] (≤)</td>
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<tr>
<td><strong>LINREG(aX+b)</strong></td>
<td>Fits Xlistname and Ylistname with frequency freqlistname. (I)</td>
<td>STAT CALC (LINREG(aX+b))</td>
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<tr>
<td><strong>LN</strong> value</td>
<td>Returns the natural logarithm of value. (F)</td>
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<tr>
<td><strong>LN</strong> list</td>
<td>Returns a list of the natural logarithm for each list element. (F)</td>
<td>LN</td>
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<tr>
<td>LNREG Xlistname,Ylistname</td>
<td>Fits Xlistname and Ylistname to the logarithmic model. (I)</td>
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<tr>
<td>LNREG Xlistname,Ylistname, freqlistname</td>
<td>Fits Xlistname and Ylistname to the logarithmic model with frequency freqlistname. (I)</td>
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<tr>
<td>LOG value</td>
<td>Returns the logarithm of value. (F)</td>
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<td>LOG list</td>
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<td>Selects manual simplification mode for fractions. (I)</td>
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<td>MAX(valueA,valueB)</td>
<td>Returns the larger of valueA and valueB. (F)</td>
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<td>MAX(list)</td>
<td>Returns the largest element in list. (F)</td>
<td></td>
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<tr>
<td>MAX(listA,listB)</td>
<td>Returns a list of the larger of each pair of elements in listA and listB. (F)</td>
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<tr>
<td>MAX(list,value) or MAX(value,list)</td>
<td>Returns a list of the larger of each list element compared to value. (F)</td>
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<tr>
<td>MEAN(list)</td>
<td>Returns the mean of list. (F)</td>
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<tr>
<td>MEAN(list,frequency)</td>
<td>Returns the mean of list with frequency frequency. (F)</td>
<td></td>
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<tr>
<td>MEDIAN(list)</td>
<td>Returns the median of list. (F)</td>
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<td></td>
</tr>
<tr>
<td>MEDIAN(list,frequency)</td>
<td>Returns the median of list with frequency frequency. (F)</td>
<td></td>
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</tr>
<tr>
<td>MIN(valueA,valueB)</td>
<td>Returns the smaller of valueA and valueB. (F)</td>
<td></td>
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</tr>
<tr>
<td>MIN(list)</td>
<td>Returns the smallest element in list. (F)</td>
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<td><strong>MIN(listA,listB)</strong></td>
<td>Returns a list of the smaller of each pair of elements in listA and listB. (F)</td>
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<tr>
<td><strong>MIN(list,value) or MIN(value,list)</strong></td>
<td>Returns a list of the smaller of each list element compared to value. (F)</td>
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<td><strong>Multiplication: valueA·valueB</strong></td>
<td>Returns valueA times valueB. (F)</td>
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<tr>
<td><strong>Multiplication: valueA·list or list·value</strong></td>
<td>Returns a list containing each value times each list element. (F)</td>
<td>2-4</td>
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<tr>
<td><strong>Multiplication: listA·listB</strong></td>
<td>Returns a list of listA elements times listB elements. (F)</td>
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<tr>
<td><strong>valueA nCr valueB</strong></td>
<td>Returns the combinations of valueA (integer ≥ 0) taken valueB (integer ≥ 0) at a time. (F)</td>
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<tr>
<td><strong>value nCr list</strong></td>
<td>Returns a list of the combinations of value (integer ≥ 0) taken each element in list (integer ≥ 0) at a time. (F)</td>
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<tr>
<td><strong>list nCr value</strong></td>
<td>Returns a list of the combinations of each element (integer ≥ 0) in list taken value (integer ≥ 0) at a time. (F)</td>
<td>2-13</td>
</tr>
<tr>
<td><strong>listA nCr listB</strong></td>
<td>Returns a list of the combinations of each element (integer ≥ 0) in listA taken each element in listB (integer ≥ 0) at a time. (F)</td>
<td>2-13</td>
</tr>
<tr>
<td><strong>NDERIV(expression, variable,value)</strong></td>
<td>Returns the approximate numerical derivative of expression with respect to variable at value.  ε is 1ε-3. (F)</td>
<td>2-9</td>
</tr>
<tr>
<td><strong>NDERIV(expression, variable,value,ε)</strong></td>
<td>Returns the approximate numerical derivative of expression with respect to variable at value, with a specified ε. (F)</td>
<td>2-9</td>
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A-10  Tables and Reference Information
<p>| <strong>Negation:</strong> <code>-value</code> | Returns the negative of value. <strong>(F)</strong> | 2-6 |
| <strong>Negation:</strong> <code>-list</code> | Returns a list with each list element negated. <strong>(F)</strong> | 2-6 |
| <strong>NORMAL</strong> | Sets normal display mode. <strong>(l)</strong> | <strong>† (MODE</strong> <em>(NORMAL)</em> <strong>) 1-10</strong> |
| <strong>Not Equal:</strong> <code>valueA ≠ valueB</code> | Returns 1 if <code>valueA ≠ valueB</code>. Returns 0 if <code>valueA = valueB</code>. <strong>(F)</strong> | 2-16 |
| <strong>Not Equal:</strong> <code>listA ≠ listB</code> | Applies the <code>≠</code> test to each element of <code>listA</code> and <code>listB</code> and returns a list. <strong>(F)</strong> | 2-16 |
| <strong>Not Equal:</strong> <code>list ≠ value</code> or <code>value ≠ list</code> | Applies the <code>≠</code> test to each element of <code>list</code> and <code>value</code> and returns a list. <strong>(F)</strong> | 2-16 |
| <code>valueA \text{nPr} valueB</code> | Returns a list of the permutations of <code>valueA</code> (integer ≥ 0) taken <code>valueB</code> (integer ≥ 0) at a time. <strong>(F)</strong> | <strong>MATH</strong> <strong>PRB</strong> <em>(nPr)</em> | 2-13 |
| <code>value \text{nPr} list</code> | Returns a list of the permutations of <code>value</code> (integer ≥ 0) taken each element in <code>list</code> (integer ≥ 0) at a time. <strong>(F)</strong> | <strong>MATH</strong> <strong>PRB</strong> <em>(nPr)</em> | 2-13 |
| <code>list \text{nPr} value</code> | Returns a list of the permutations of each element (integer ≥ 0) in <code>list</code> taken <code>value</code> (integer ≥ 0) at a time. <strong>(F)</strong> | <strong>MATH</strong> <strong>PRB</strong> <em>(nPr)</em> | 2-13 |
| <code>listA \text{nPr} listB</code> | Returns a list of the permutations of each element (integer ≥ 0) in <code>listA</code> taken each element in <code>listB</code> (integer ≥ 0) at a time. <strong>(F)</strong> | <strong>MATH</strong> <strong>PRB</strong> <em>(nPr)</em> | 2-13 |
| <strong>1-VAR STATS</strong> <code>listname</code> | Performs one-variable analysis using <code>listname</code> and a frequency of 1. <strong>(l)</strong> | <strong>STAT</strong> <strong>CALC</strong> <em>(1-VAR STATS)</em> | 9-15 |
| <strong>1-VAR STATS</strong> <code>Xlistname</code>, <code>freqlistname</code> | Performs one-variable analysis using <code>Xlistname</code> and frequency <code>freqlistname</code>. <strong>(l)</strong> | <strong>STAT</strong> <strong>CALC</strong> <em>(1-VAR STATS)</em> | 9-15 |
| <strong>PARAM</strong> | Sets parametric graphing mode. <strong>† (MODE</strong> <em>(PARAM)</em> <strong>) 1-11</strong> |</p>
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<td>PAUSE</td>
<td>Suspends execution of the program until ENTER is pressed. (l)</td>
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<td>Pi</td>
<td>Returns the value of π rounded to 13 digits. (F)</td>
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<td>PLOTn(type,Xlist,Ylist)</td>
<td>Plots stat plot n (1-3) of type (cyan) or (blacks) for Xlist and Ylist coordinate pairs.</td>
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<tr>
<td>PLOTn(type,Xlist,Ylist, mark)</td>
<td>Plots stat plot n (1-3) of type (cyan) or (blacks) for Xlist and Ylist coordinate pairs with the specified type of mark. (I)</td>
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<tr>
<td>PLOTn(type,Xlist) or PLOTn(type,Xlist,Flist)</td>
<td>Plots stat plot n (1-3) of type (cyan) or (blacks) for Xlist with frequency Flist. If Flist is omitted, frequency = 1. (I)</td>
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<td>PLOTSOFF</td>
<td>Deselects all stat plots. (I)</td>
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<tr>
<td>PLOTSOFF plot#,plot# . . .</td>
<td>Deselects stat plot1, plot2, or plot3. (I)</td>
</tr>
<tr>
<td>PLOTSON</td>
<td>Selects all stat plots. (I)</td>
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<tr>
<td>PLOTSON plot#,plot# . . .</td>
<td>Selects stat plot1, plot2, or plot3. (I)</td>
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<tr>
<td>Power: value^power</td>
<td>Returns value raised to power. (F)</td>
</tr>
<tr>
<td>Power: list^power</td>
<td>Returns a list of each element raised to the value of power. (F)</td>
</tr>
<tr>
<td>Power: value^list</td>
<td>Returns a list of value raised to the power of each list element. (F)</td>
</tr>
<tr>
<td>Power: listA^listB</td>
<td>Returns a list of each listA element raised to the power of each listB element. (F)</td>
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<tr>
<td>Power of ten: 10^power</td>
<td>Returns 10 raised to the value of power. (F)</td>
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<tr>
<td>Power of ten: 10^list</td>
<td>Returns a list of 10 raised to the power of each list element. (F)</td>
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<td>Executes the program programname.</td>
<td>PRGM_programname()</td>
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<td>PROD list</td>
<td>Returns the product of elements in list.</td>
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<td>P Rx(R,θ)</td>
<td>Returns the rectangular coordinate x, given the polar coordinates R and θ.</td>
<td>Rx(R,θ)</td>
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<tr>
<td>P Rx(list,θ)</td>
<td>Returns a list of x coordinates, given the R coordinates in Rlist and a single θ.</td>
<td>Rx(list,θ)</td>
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<tr>
<td>P Rx(R,list)</td>
<td>Returns a list of x coordinates, given the single R coordinate and the θ coordinates in list.</td>
<td>Rx(R,list)</td>
<td>2-15</td>
</tr>
<tr>
<td>P Rx(list,θ)</td>
<td>Returns a list of x coordinates, given the R and θ coordinates in Rlist and θlist.</td>
<td>Rx(list,θ)</td>
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<tr>
<td>P Ry(R,θ)</td>
<td>Returns rectangular coordinate y, given polar coordinates R and θ.</td>
<td>Ry(R,θ)</td>
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<tr>
<td>P Ry(R,list)</td>
<td>Returns a list of y coordinates, given the R coordinates in Rlist and a single θ coordinate.</td>
<td>Ry(R,list)</td>
<td>2-15</td>
</tr>
<tr>
<td>P Ry(list,θ)</td>
<td>Returns a list of y coordinates, given a single R coordinate and the θ coordinates in θlist.</td>
<td>Ry(list,θ)</td>
<td>2-15</td>
</tr>
<tr>
<td>P Ry(R,list)</td>
<td>Returns a list of y coordinates, given the R coordinates in Rlist and the θ coordinates in θlist.</td>
<td>Ry(R,list)</td>
<td>2-15</td>
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<td>PT-CHANGE(X,Y)</td>
<td>Toggles the point at (X,Y).</td>
<td>PT-CHANGE(X,Y)</td>
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<td>PT-OFF(X,Y)</td>
<td>Erases the point at (X,Y).</td>
<td>PT-OFF(X,Y)</td>
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<tr>
<td>PT-ON(X,Y)</td>
<td>Draws the point at (X,Y).</td>
<td>PT-ON(X,Y)</td>
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</table>
### PWRREG

- **Syntax:** `PWRREG Xlistname, Ylistname`  
  Fits `Xlistname` and `Ylistname` to the power model. *(I)*  
  STAT CALC (PWRREG)  

- **Syntax:** `PWRREG Xlistname, Ylistname, freqlistname`  
  Fits `Xlistname` and `Ylistname` to the power model with frequency `freqlistname`. *(I)*  
  STAT CALC (PWRREG)  

### QUADREG

- **Syntax:** `QUADREG Xlistname, Ylistname`  
  Fits `Xlistname` and `Ylistname` to the quadratic model. *(I)*  
  STAT CALC (QUADREG)  

- **Syntax:** `QUADREG Xlistname, Ylistname, freqlistname`  
  Fits `Xlistname` and `Ylistname` to the quadratic model with frequency `freqlistname`. *(I)*  
  STAT CALC (QUADREG)  

### Radian Notation

- **Syntax:** `value r`  
  Interprets `value` as an angle in radians. *(I)*  
  2nd ANGLE (r)  

### RAND

- **Syntax:** `RAND()`  
  Returns a random number between 0 and 1. *(F)*  
  MATH PRB (RAND)  

### RANDINT

- **Syntax:** `RANDINT(lower, upper)`  
  Returns a random integer between `lower` and `upper`. *(F)*  
  MATH PRB (RANDINT())  

- **Syntax:** `RANDINT(lowerlist, upper)`  
  Returns a list of random integers between each element of `lowerlist` and `upper`. *(F)*  
  MATH PRB (RANDINT())  

- **Syntax:** `RANDINT(lower, upperlist)`  
  Returns a list of random integers between `lower` and each element of `upperlist`. *(F)*  
  MATH PRB (RANDINT())  

- **Syntax:** `RANDINT(lowerlist, upperlist)`  
  Returns a list of random integers between each element of `lowerlist` and `upperlist`. *(F)*  
  MATH PRB (RANDINT())  

### REMAINDER

- **Syntax:** `REMAINDER(valueA, valueB)`  
  Returns the remainder from the division of `valueA` by `valueB`. *(F)*  
  MATH NUM (REMAINDER())  

- **Syntax:** `REMAINDER(value, list)`  
  Returns a list of remainders from the division of `value` by each element in `list`. *(F)*  
  MATH NUM (REMAINDER())
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<td>REMAINDER(list, value)</td>
<td>Returns a list of remainders from the division of each element in list by value.</td>
<td>MATH NUM</td>
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<tr>
<td>REMAINDER(listA, listB)</td>
<td>Returns a list of remainders from the division of each element in listA by the each element in listB.</td>
<td>MATH NUM</td>
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<tr>
<td>Return</td>
<td>Returns to the calling program.</td>
<td>† PRG CTL (RETURN)</td>
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<td>nthrootX(value)</td>
<td>Returns nthroot of value.</td>
<td>MATH (x√)</td>
<td>2-8</td>
</tr>
<tr>
<td>nthrootX\list</td>
<td>Returns a list of nthroot for each list element.</td>
<td>MATH (x√)</td>
<td>2-8</td>
</tr>
<tr>
<td>listX\value</td>
<td>Returns list roots of value.</td>
<td>MATH (x√)</td>
<td>2-8</td>
</tr>
<tr>
<td>listA\X\listB</td>
<td>Returns a list of listA roots of listB.</td>
<td>MATH MATH (x√)</td>
<td>2-8</td>
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<tr>
<td>ROUND(value)</td>
<td>Returns value rounded to 10 digits.</td>
<td>MATH NUM (ROUND)</td>
<td>2-10</td>
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<tr>
<td>ROUND(value,#decimals)</td>
<td>Returns value rounded to #decimals (≤ 9).</td>
<td>MATH NUM (ROUND)</td>
<td>2-10</td>
</tr>
<tr>
<td>ROUND(list)</td>
<td>Returns list elements rounded to 10 digits.</td>
<td>MATH NUM (ROUND)</td>
<td>2-10</td>
</tr>
<tr>
<td>ROUND(list,#decimals)</td>
<td>Returns list elements rounded to #decimals (≤ 9).</td>
<td>MATH NUM (ROUND)</td>
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<tr>
<td>R►Pr(X,Y)</td>
<td>Returns the polar coordinate r, given the rectangular coordinates X and Y.</td>
<td>2nd ANGLE (°r°θ)</td>
<td>2-15</td>
</tr>
<tr>
<td>R►Pr(Xlist,Y)</td>
<td>Returns a list of r coordinates, given the X coordinates in Xlist and a single Y coordinate.</td>
<td>2nd ANGLE (°r°θ)</td>
<td>2-15</td>
</tr>
<tr>
<td>R►Pr(X,Ylist)</td>
<td>Returns a list of r coordinates, given a single X coordinate and the Y coordinates in Ylist.</td>
<td>2nd ANGLE (°r°θ)</td>
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<tr>
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<td></td>
</tr>
<tr>
<td>---------------</td>
<td>------------------------------------------------------------------------------</td>
<td>------------------</td>
<td></td>
</tr>
<tr>
<td>( R\angle P_X )</td>
<td>Returns a list of ( r ) coordinates, given the ( X ) coordinates in ( Xlist ) and the ( Y ) coordinates in ( Ylist ).</td>
<td>[angle]</td>
<td></td>
</tr>
<tr>
<td>( R\angle P_\theta(X,Y) )</td>
<td>Returns the polar coordinate ( \theta ), given the rectangular coordinates ( X ) and ( Y ).</td>
<td>(F)</td>
<td></td>
</tr>
<tr>
<td>( R\angle P_\theta(Xlist,Y) )</td>
<td>Returns a list of ( \theta ) coordinates, given the ( X ) coordinates in ( Xlist ) and a single ( Y ) coordinate.</td>
<td>(F)</td>
<td></td>
</tr>
<tr>
<td>( R\angle P_\theta(X,Ylist) )</td>
<td>Returns a list of ( \theta ) coordinates, given a single ( X ) coordinate and the ( Y ) coordinates in ( Ylist ).</td>
<td>(F)</td>
<td></td>
</tr>
<tr>
<td>( R\angle P_\theta(Xlist,Ylist) )</td>
<td>Returns a list of ( \theta ) coordinates, given the ( X ) coordinates in ( Xlist ) and the ( Y ) coordinates in ( Ylist ).</td>
<td>(F)</td>
<td></td>
</tr>
<tr>
<td>SCI</td>
<td>Sets scientific display mode.</td>
<td>† [mode]</td>
<td></td>
</tr>
</tbody>
</table>
| seq(expression,variable,
begin,end,increment) | Returns a list created by evaluating expression for variable, from begin to end by increment. | [list] [ops] [seq] |
<p>| sequential    | Sets sequential graphing mode. | † [mode]         |
| SHADE(lowerfunc,upperfunc) | Shades the area above ( lowerfunc ) and below ( upperfunc ). | (I) [draw] [shade] |
| SHADE(lowerfunc,upperfunc,resolution) | Shades the area above ( lowerfunc ), below ( upperfunc ), and with resolution (1 through 9). | (I) [draw] [shade] |
| SHADE(lowerfunc,upperfunc,resolution,Xleft) | Shades the area above ( lowerfunc ), below ( upperfunc ), to right of ( X=Xleft ), and with resolution (1 through 9). | (I) [draw] [shade] |</p>
<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
<th>Menu</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHADE(lowerfunc,</td>
<td>Shades the area above lowerfunc, below upperfunc, to right of X=Xleft, to</td>
<td>2nd DRAW</td>
</tr>
<tr>
<td>upperfunc,resolution,</td>
<td>left of X=Xright, and with resolution (1 through 9).</td>
<td>(SHADE)</td>
</tr>
<tr>
<td>Xleft,Xright)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHADE_Y&gt;func1,func2, . . .</td>
<td>Shades the area above func1 with vertical pattern and above func2 with</td>
<td>2nd DRAW</td>
</tr>
<tr>
<td></td>
<td>diagonal pattern (lower left to upper right), etc. (I)</td>
<td>(SHADE_Y&gt;)</td>
</tr>
<tr>
<td>SHADE_Y&lt;func3,func4, . . .</td>
<td>Shades the area below func3 with horizontal pattern and below func4 with</td>
<td>2nd DRAW</td>
</tr>
<tr>
<td></td>
<td>diagonal pattern (upper left to lower right), etc. (I)</td>
<td>(SHADE_Y&lt;)</td>
</tr>
<tr>
<td>fraction⇒SIMP</td>
<td>Simplifies fraction by its lowest common factor. (F)</td>
<td>FRAC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(SIMP)</td>
</tr>
<tr>
<td>(fraction,factor)⇒SIMP</td>
<td>Simplifies fraction by the specified factor, which must be an integer. (F)</td>
<td>FRAC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(SIMP)</td>
</tr>
<tr>
<td>SIMUL</td>
<td>Sets simultaneous graphing mode. (I)</td>
<td>⇧ MODE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(SIMUL)</td>
</tr>
<tr>
<td>SIN value</td>
<td>Returns the sine of value. (I)</td>
<td>SIN</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIN list</td>
<td>Returns a list of the sine for each list element. (F)</td>
<td>SIN</td>
</tr>
<tr>
<td>SIN⁻¹ value</td>
<td>Returns the arcsine of value. (F)</td>
<td>2nd [SIN⁻¹]</td>
</tr>
<tr>
<td>SIN⁻¹ list</td>
<td>Returns a list of the arcsine for each list element. (F)</td>
<td>2nd [SIN⁻¹]</td>
</tr>
<tr>
<td>SORTA(listname)</td>
<td>Sorts listname elements in ascending order. (I)</td>
<td>2nd [LIST] OPS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(SORTA)</td>
</tr>
<tr>
<td>SORTA(keylistname,</td>
<td>Sorts the elements of keylistname in ascending order with dependlist1,</td>
<td>2nd [LIST] OPS</td>
</tr>
<tr>
<td>dependlist1, dependlist2, . . .</td>
<td>dependlist2 . . . as dependent lists. (I)</td>
<td>(SORTA)</td>
</tr>
</tbody>
</table>

Tables and Reference Information  A-17
<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SORTD(listname)</td>
<td>Sorts the elements of listname in descending order. (I)</td>
</tr>
<tr>
<td>SORTD(keylistname,</td>
<td>Sorts the elements of keylistname in descending order with dependlist1,</td>
</tr>
<tr>
<td>dependlist1, . . .)</td>
<td>dependlist2 . . . as dependent lists. (I)</td>
</tr>
<tr>
<td>Square: value(^2)</td>
<td>Returns value multiplied by itself. (F)</td>
</tr>
<tr>
<td>Square: list(^2)</td>
<td>Returns a list of each list element squared. (F)</td>
</tr>
<tr>
<td>Square Root: √value</td>
<td>Returns the square root of value. (F)</td>
</tr>
<tr>
<td>Square Root: √list</td>
<td>Returns a list of the square roots of each list element. (F)</td>
</tr>
<tr>
<td>STOP</td>
<td>Stops program execution and returns to the Home screen. (I)</td>
</tr>
<tr>
<td>Store: value⇒variable</td>
<td>Stores value to variable. (I)</td>
</tr>
<tr>
<td>Store: list⇒listname</td>
<td>Stores list to listname. (I)</td>
</tr>
<tr>
<td>Store: &quot;expression&quot;⇒Yn or &quot;expression&quot;⇒XnT or &quot;expression&quot;⇒YnT</td>
<td>Stores expression to Yn XnT or YnT function. (I)</td>
</tr>
<tr>
<td>Subtraction: valueA−valueB</td>
<td>Subtracts valueB from valueA. (F)</td>
</tr>
<tr>
<td>Subtraction: value−list</td>
<td>Subtracts list elements from value and returns a list. (F)</td>
</tr>
<tr>
<td>Subtraction: list−value</td>
<td>Subtracts value from list elements and returns a list. (F)</td>
</tr>
<tr>
<td>Subtraction: listA−listB</td>
<td>Subtracts each listB element from each listA element and returns a list. (F)</td>
</tr>
<tr>
<td>SUM list</td>
<td>Returns the sum of elements in list. (F)</td>
</tr>
<tr>
<td>TAN value</td>
<td>Returns the tangent of value. (F)</td>
</tr>
<tr>
<td><strong>TAN</strong> list</td>
<td>Returns a list of the tangent for each list element. (F)</td>
</tr>
<tr>
<td>-------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td><strong>TAN^-1</strong> value</td>
<td>Returns the arctangent of value. (F)</td>
</tr>
<tr>
<td><strong>TAN^-1</strong> list</td>
<td>Returns a list of the arctangent for each list element. (F)</td>
</tr>
</tbody>
</table>

**THEN**  
*See IF:THEN*

| **TRACE** | Displays a graph and enters Trace mode. (I) | † [TRACE] | 4-13 |
| **2-VAR STATS** Xlistname, Ylistname | Performs two-variable analysis using Xlistname and Ylistname. (I) | STAT CALC (2-VAR STATS) | 9-15 |
| **2-VAR STATS** Xlistname, Ylistname, freqlistname | Performs two-variable analysis using Xlistname and Ylistname with frequency freqlistname. (I) | STAT CALC (2-VAR STATS) | 9-15 |
| **VERTICAL X** | Draws a vertical line at value X. (I) | † [DRAW] DRAW (VERTICAL) | 7-5 |
| **ZBOX** | Displays a graph to allow the user to define new viewing window. (I) | † [ZOOM] (ZBOX) | 4-15 |
| **ZDECGIMAL** | Displays a graph in new viewing window. (I) | † [ZOOM] (ZDECGIMAL) | 4-17 |
| **ZOOM IN** | Displays a graph in new viewing window. (I) | † [ZOOM] (ZOOM IN) | 4-16 |
| **ZOOM OUT** | Displays a graph in new viewing window. (I) | † [ZOOM] (ZOOM OUT) | 4-16 |
| **ZSQRE** | Displays a graph in new viewing window. (I) | † [ZOOM] (ZSQRE) | 4-17 |
| **ZSTDNAR** | Displays a graph in new viewing window. (I) | † [ZOOM] (ZSTDNAR) | 4-17 |
| **ZTR** | Displays a graph in new viewing window. (I) | † [ZOOM] (ZTR) | 4-17 |
Menus begin in the upper left of the keyboard. Default values are shown.

![TI-80 Menu Map]

**Y=**
- **(FUNC mode)**
  - Y1=
  - Y2=
  - Y3=
  - Y4=
- **(PARAM mode)**
  - X1T=
  - Y1T=
  - X2T=
  - Y2T=
  - X3T=
  - Y3T=

**WINDOW**
- **(FUNC mode)**
  - WINDOW
  - XMIN=10
  - XMAX=10
  - XSCL=1
  - YMIN=10
  - YMAX=10
  - YSCL=1
- **(PARAM mode)**
  - WINDOW
  - XMIN=0
  - XMAX=2π
  - XSCL=1
  - YMIN=0
  - YMAX=10
  - YSCL=1

**2nd [TblSet]**
- **TABLE SETUP**
  - TBLMIN=0
  - ΔTBL=1

**ZOOM**
- **ZOOM**
  - 1:ZBOX
  - 2:ZOOM IN
  - 3:ZOOM OUT
  - 4:ZDECEIMAL
  - 5:ZSQUARE
  - 6:ZSTANDARD
  - 7:ZTRIG

**MODE**
- **NORMAL SCI**
- **FLOAT 0123456789**
- **RADIANS DEGREE**
- **a_b\c \b\c**
- **AUTOSIMP MANSIMP**
- **FUNC PARAM**
- **CONNECTED DOT**
- **SEQUENTIAL SIMUL**

**MAXE (in program editor)**
- **MODE**
  - 1: NORMAL
  - 2: SCI
  - 3: FLOAT
  - 4: FIX
  - 5: RADIANS
  - 6: DEGREES
  - 7: a_b\c
  - 8: \b\c
  - 9: AUTOSIMP
  - 0: MANSIMP
  - A: FUNC
  - B: PARAM
  - C: CONNECTED
  - D: DOT
  - E: SEQUENTIAL
  - F: SIMUL
STAT PLOTS
1: PLOT1...
   OFF L1 L2
2: PLOT2...
   OFF L1 L2
3: PLOT3...
   OFF L1 L2
4: PLOT OFF
5: PLOT ON

Screen for " or " plots
(1-variable plots)

PLOTn
ON OFF
TYPE: L1 L2 L3 L4 L5 L6
XL: L1 L2 L3 L4 L5 L6
F: L1 L2 L3 L4 L5 L6

Screen for " or " plots
(2-variable plots)

PLOTn
ON OFF
TYPE: L1 L2 L3 L4 L5 L6
XL: L1 L2 L3 L4 L5 L6
YL: L1 L2 L3 L4 L5 L6
MARK: * + .

STAT
EDIT  CALC
1: EDIT...
   1: 1-VAR STATS
2: SORTA(
   2: 2-VAR STATS
3: SORTD(
   3: LINREG(aX+b)
4: CLRLIST
   4: QUADREG
5: LINREG(a+bX)
6: LNREG
7: EXPREG
8: PWRREG

Tables and Reference Information  A-21
| (2nd) [List] |
|----|----|----|
| OPS | MATH |
| 1: SORTA | 1: MIN |
| 2: SORTD | 2: MAX |
| 3: DIM | 3: MEAN |
| 4: SEQ | 4: MEDIAN |
| 5: SUM |
| 6: PROD |

| MATH |
| MATH | NUM | PRB |
| 1: INT | 1: ROUND | 1: RAND |
| 2: DEC | 2: IPart | 2: nPr |
| 3: ³ | 3: FPart | 3: nCr |
| 4: ³√ | 4: INT | 4: ! |
| 5: ³√ | 5: MIN | 5: RANDINT |
| 6: NDERIV | 6: MAX | 7: REMAINDER |

| FRAC |
| FRACTION | (2nd) [Test] | (2nd) [Angle] |
| 1: ●SIMP | 1: = | 1: ° |
| 2: ●b/c | 2: ≠ | 2: ′ |
| 3: ●a/b/c | 3: > | 3: ▣Pr( |
| 4: ●FRAC | 4: ≥ | 4: ▣P0( |
| 5: ●DEC | 5: < | 5: ▣Rx( |
| 6: ≤ | 6: ▣Ry( |

A-22  Tables and Reference Information
Tables and Reference Information   A-23
### VARS

1: WINDOW...
2: STATISTICS...
3: TABLE...
4: SIMPFAC...

#### VARS (WINDOW...)

<table>
<thead>
<tr>
<th>X/Y</th>
<th>T</th>
<th>TABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: XMIN</td>
<td>1: TMIN</td>
<td>1: TBLMIN</td>
</tr>
<tr>
<td>2: XMAX</td>
<td>2: TMAX</td>
<td>2: △TBL</td>
</tr>
<tr>
<td>3: XSCL</td>
<td>3: TSTEP</td>
<td></td>
</tr>
<tr>
<td>4: YMIN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5: YMAX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6: YSCL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7: △X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8: △Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9: XFACT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0: YFACT</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### VARS (STATISTICS...)

<table>
<thead>
<tr>
<th>X/Y</th>
<th>Σ</th>
<th>EQ</th>
<th>BOX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: n</td>
<td>1: ∑X</td>
<td>1: a</td>
<td>1: Q1</td>
</tr>
<tr>
<td>2: X</td>
<td>2: ∑X^2</td>
<td>2: b</td>
<td>2: MED</td>
</tr>
<tr>
<td>3: Sx</td>
<td>3: ∑Y</td>
<td>3: c</td>
<td>3: Q3</td>
</tr>
<tr>
<td>4: sx</td>
<td>4: ∑Y^2</td>
<td>4: r</td>
<td></td>
</tr>
<tr>
<td>5: Y</td>
<td>5: ∑XY</td>
<td>5: REGEQ</td>
<td></td>
</tr>
<tr>
<td>6: Sy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7: sy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8: MINX</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9: MAXX</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0: MINY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A: MAXY</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### X/Y (VARS)

<table>
<thead>
<tr>
<th>Y</th>
<th>XT/YT</th>
<th>ON/OFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Y1</td>
<td>1: X1T</td>
<td>1: FNON</td>
</tr>
<tr>
<td>2: Y2</td>
<td>2: Y2T</td>
<td>2: FNON</td>
</tr>
<tr>
<td>3: Y3</td>
<td>3: X2T</td>
<td></td>
</tr>
<tr>
<td>4: Y4</td>
<td>4: Y4T</td>
<td>3: X4T</td>
</tr>
<tr>
<td>4: Y4T</td>
<td>4: Y4T</td>
<td></td>
</tr>
</tbody>
</table>
MEMORY
1:CHECK RAM...
2:DELETE...
3:RESET...

MEMORY
MEM FREE  7014
REAL      14
LIST      0
Y·VARS    80
PRGM      14

DELETE:
1:NO
2:RESET

(name memory)

Resetting memory erases all data and programs.

(names include defined programs, lists, Y= equations, and user variables, in that order.)
**TI-80 Variables**

The variables listed below are used by the TI-80 in various ways. Some have restrictions on their use.

### User Variables

The variables A through Z and θ can hold only numbers—either decimals or fractions. You may store to these variables. The TI-80 can update X, Y, and T during graphing; therefore, you may wish to reserve those variables for graphing activities.

The variables L₁ through L₆ are defined as lists. You cannot store another type of data to them.

You can store any string of characters, functions, instructions, or variable names to the functions Y_n (in **FUNC** mode) and X_n and Y_n (in **PARAM** mode), by using either STOR or the Y= editor. The validity of the string is determined when the function is evaluated.

### System Variables

The values of the Window variables—XMIN, XMAX, XSCL, ΔX, TSTEP, etc.—must be real numbers. You may store to them. Since the TI-80 can update some of them, as the result of a Zoom instruction, for example, you may wish to reserve these variables for graphing activities.

The statistical result variables—n, x̄, ΣX, a, r, REGEQ, X₁, Y₁, Q₁, MED, Q₃, etc.—are reserved for use by the TI-80. You cannot store to them.
Appendix B: Service and Warranty Information

This appendix provides supplemental information that may be helpful as you use the TI-80. It includes procedures that may help you correct problems with the calculator.

<table>
<thead>
<tr>
<th>Appendix Contents</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery Information</td>
<td>B-2</td>
</tr>
<tr>
<td>Accuracy Information</td>
<td>B-8</td>
</tr>
<tr>
<td>In Case of Difficulty</td>
<td>B-10</td>
</tr>
<tr>
<td>Error Conditions</td>
<td>B-11</td>
</tr>
<tr>
<td>Service and Support Information</td>
<td>B-14</td>
</tr>
<tr>
<td>Warranty Information</td>
<td>B-15</td>
</tr>
</tbody>
</table>
Battery Information

The TI-80 uses two CR2032 lithium 3-volt batteries.

When to Replace the Batteries
As you use the TI-80, the battery voltage will gradually drop, and the display will dim. You can adjust the contrast to darken the display when this happens. If the display is dim and adjusting the contrast to level 9 does not make it dark enough, you should replace the batteries. Refer to pages B-3 through B-7 for instructions on how to change the batteries.

Battery Precautions
Follow these safety guidelines concerning batteries.

- Do not mix new and used batteries.
- Do not mix different types of batteries.
- Follow polarity diagrams carefully.
- Do not replace batteries with rechargeable batteries.
- Do not place non-rechargeable batteries in a battery charger.
- Properly dispose of used batteries immediately. Do not leave them within the reach of small children.
- Do not incinerate used batteries.

Retaining Stored Data

Caution: The TI-80 retains stored data when you are changing batteries only if you:

- Do not remove both batteries at the same time. (At least one battery must be installed at all times in order to retain memory.)
- Turn the unit off and do not turn it back on until you have changed the batteries.
- Do not allow the batteries to run down completely before changing them.

Follow the steps on pages B-3 through B-7 when changing batteries.
To change the batteries, first:

a. **Turn the calculator off.**

b. Replace the plastic slide cover over the keys.

c. Turn the calculator so that the back is facing you.

1. Placing your thumb on the ridged area of the plastic battery compartment cover, push down slightly and slide the cover to the right until you can lift off the cover.

2. Push the red switch up to free the metal battery cover over the lower battery.
3. Slide the metal battery cover away from the battery. The battery pops up.

4. Remove the old battery. Insert a new battery, positive side (+) up.

5. Hold the new battery in place and slide the metal battery cover back into position over the battery.
6. Push the red switch all the way down to free the metal battery cover over the upper battery.

7. Slide the metal battery cover away from the battery.

8. Remove the old battery. Insert a new battery, positive side (+) up.
9. Hold the new battery in place and slide the metal battery cover back into position over the battery.

10. Push the red switch to its center position to lock the metal covers and batteries into place.

**Note:** The calculator will not turn on unless the red switch is in the center position.
Replace the plastic battery compartment cover. Turn the calculator on and adjust the contrast display.

To adjust the display contrast, press and release the 2nd key. To increase the contrast (darken the screen), press and hold 2. To decrease the contrast (lighten the screen), press and hold 2.
Accuracy Information

To maximize accuracy, the TI-80 carries more digits internally than it displays.

**Computational Accuracy**

Values in memory are stored using up to 13 digits with a two-digit exponent.

- You can store values in the Window variables using up to 10 digits (13 digits for Xscl, Yscl, and Tstep).
- When a value is displayed, the displayed value is rounded as specified by the MODE setting (Chapter 1), with a maximum of 10 digits and a two-digit exponent.
- REGEQ displays up to 13 digits.

**Graphing Accuracy**

Xmin is the center of the leftmost pixel, Xmax is the center of the next to the rightmost pixel. (The rightmost pixel is reserved for the busy indicator.) ΔX is the distance between the centers of two adjacent pixels.

- ΔX is calculated as (Xmax−Xmin)/62.
- If ΔX is entered from the Home screen or a program, then Xmax is calculated as Xmin+ΔX×62.

Ymin is the center of the next to the bottom pixel, Ymax is the center of the top pixel. ΔY is the distance between the centers of two adjacent pixels.

- ΔY is calculated as (Ymax−Ymin)/46.
- If ΔY is entered from the Home screen or a program, then Ymax is calculated as Ymin+ΔY×46.

Cursor coordinates are displayed as six characters, which may include a negative sign, decimal point, and exponent.
Following is a table of functions and the range of input values for each.

<table>
<thead>
<tr>
<th>Function</th>
<th>Input Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIN x, COS x, TAN x</td>
<td>0 ≤</td>
</tr>
<tr>
<td>SIN^{-1} x, COS^{-1} x</td>
<td>-1 ≤ x ≤ 1</td>
</tr>
<tr>
<td>LN x, LOG x</td>
<td>10^{-100} &lt; x &lt; 10^{100}</td>
</tr>
<tr>
<td>e^x</td>
<td>-10^{100} &lt; x ≤ 230.2585092993</td>
</tr>
<tr>
<td>10^x</td>
<td>-10^{100} &lt; x &lt; 100</td>
</tr>
<tr>
<td>√x</td>
<td>0 ≤ x &lt; 10^{100}</td>
</tr>
<tr>
<td>x!</td>
<td>0 ≤ x ≤ 69, where x is an integer</td>
</tr>
</tbody>
</table>

Following is a table of functions and the range of the result for each.

<table>
<thead>
<tr>
<th>Function</th>
<th>Range of Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIN^{-1} x, TAN^{-1} x</td>
<td>-90° to 90° or -π/2 to π/2 (radians)</td>
</tr>
<tr>
<td>COS^{-1} x</td>
<td>0° to 180° or 0 to π (radians)</td>
</tr>
</tbody>
</table>
In Case of Difficulty

If you have difficulty operating the calculator, the following suggestions may help you to correct the problem.

Handling a Difficulty

Follow these procedures if you have difficulties.

1. If you cannot see anything on the display, perhaps the display contrast needs adjusting.
   
   Press and release the 2 key. To increase the contrast (darken the screen), press and hold 4. To decrease the contrast (lighten the screen), press and hold 8.
   
   You will find additional information on display contrast on page 1-3.

2. If after adjusting the display contrast, the calculator does not appear to be working at all, be sure the batteries are installed properly and that they are fresh. Refer to “Battery Information” beginning on page B-2 for more details.

   Note: Make sure the red switch in the battery compartment is in the center position.

3. If an error occurs, follow the procedure on page 1-22.
   
   Refer to the more detailed explanations about specific errors beginning on page B-11, if necessary.

4. If the cursor is a checker-board pattern, memory is full.
   
   Press 2nd MEM DELETE... and delete some items from memory. See Chapter 12 for additional information about memory management.

5. If the dotted-line busy indicator is displayed, a graph or program is paused, and the TI-80 is waiting for input.
   
   Press ENTER to continue or 0 to break.
Error Conditions

When the TI-80 detects an error, it displays ERR: message and the error menu. The general procedure for correcting errors is described on page 1-22. The error messages, their possible causes, and suggestions for correction are shown below.

<table>
<thead>
<tr>
<th>Error Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ARGUMENT</strong></td>
<td>A function or instruction does not have the correct number of arguments. See Appendix A and the appropriate chapter.</td>
</tr>
<tr>
<td><strong>BREAK</strong></td>
<td>You have pressed the 0 key to break execution of a program, halt a Draw instruction, or stop evaluation of an expression.</td>
</tr>
<tr>
<td><strong>DATA TYPE</strong></td>
<td>You have entered a value or variable that is the wrong data type.</td>
</tr>
<tr>
<td></td>
<td>• A function (including implied multiplication) or an instruction has an argument that is an invalid data type; for example, a list where a real number is required. See Appendix A and the appropriate chapter.</td>
</tr>
<tr>
<td></td>
<td>• You are attempting to store to an incorrect data type; for example, a list to a real variable.</td>
</tr>
<tr>
<td></td>
<td>• In function graphing or parametric graphing, you have generated a list result rather than a single value; for example, attempting to graph $Y = {1,2,3} * X$.</td>
</tr>
<tr>
<td><strong>DIM MISMATCH</strong></td>
<td>You are attempting to perform an operation that uses more than one list, but the dimensions do not match.</td>
</tr>
<tr>
<td><strong>DOMAIN</strong></td>
<td>Typically, this occurs when the value of an argument does not fall within a specified range.</td>
</tr>
<tr>
<td></td>
<td>• You are attempting to divide by zero.</td>
</tr>
<tr>
<td></td>
<td>• You are attempting a logarithmic or power regression with a ^X or an exponential or power regression with a ^Y.</td>
</tr>
<tr>
<td></td>
<td>• A zero value for e for NDERIV( will result in this error. This error does not occur during graphing because the TI-80 allows for undefined values on a graph.</td>
</tr>
<tr>
<td>Error Type</td>
<td>Description</td>
</tr>
<tr>
<td>--------------------</td>
<td>------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| INCREMENT          | • The increment in SEQ is 0 or has the wrong sign. This error does not occur during graphing. The TI-80 allows for undefined values on a graph.  
                      • The increment in FOR is 0 or has the wrong sign.                                               |
| INVALID            | You are attempting to reference a variable or use a function in a place where it is not valid. For example, Y_n cannot reference Y, XMIN, ΔX, or TBLMIN. |
| INVALID DIM        | • The dimension of the argument is not appropriate for the operation.                                
                      • List element dimensions must be integers between 1 and 99; for example, L1(100) will cause an error. |
| LABEL              | The label in the GOTO instruction is not defined with a LBL instruction in the program.             |
| MEMORY             | • There is insufficient memory in which to perform the desired command. You must delete item(s) from memory (Chapter 12) before executing this command.  
                      • Using an IF/THEN or FOR with a GOTO that branches out of the loop can also cause this error because the END statement that terminates the loop is never reached. |
| MODE               | You are attempting a SIMP in AUTOSIMP mode.                                                         |
| NEST LEVEL         | This error occurs when any nested combination of function evaluation, NDERIV or SEQ exceeds 5 levels.|
| OVERFLOW           | You are attempting to enter, or you have calculated, a number that is beyond the range of the calculator. This error does not occur during graphing. The TI-80 allows for undefined values on a graph. |
STAT
• You are attempting a linear regression with a vertical line.
• Statistical analyses must have at least two data points;
  QUADREG must have at least three data points.
• The list of \( s \) (frequency) elements must be \( \geq 0 \), and at least one \( F \) value must be \( \geq 0 \).
• The frequency list, when used for “sorting” statistics
  (median, \( Q_1 \), \( Q_3 \), or boxplot), must be an integer \( \geq 0 \) and \( \leq 99 \).
• \( (XMAX-XMIN)/XSCL \) must be \( \leq 31 \) for a histogram.

STAT PLOT
You are trying to display a graph when there is a statistical plot turned on that uses an undefined list.

SYNTAX
The command contains a syntax error. Look for misplaced functions, arguments, parentheses, or commas. See Appendix A and the appropriate chapter.

UNDEFINED
You are attempting to reference a variable that is not currently defined. For example, a statistical variable , which
has no current value because a list has been edited, has been referenced.

WINDOW RANGE
There is a problem with the Window variables.
• You may have defined \( XMAX\leq XMIN, YMAX\leq YMIN, \)
  \( TSTEP=0 \), or \( TMAX\leq TMIN \) and \( TSTEP>0 \) (or vice versa).
• The Window variables are too small or too large to graph correctly. This can occur if you attempt to zoom in or out so far that you are not within the numerical range of the calculator.

ZOOM
A point or a line, rather than a box, is defined in ZBOX; or a math error has resulted from a Zoom operation.
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