Chapter 12: Statistics

Getting Started: Pendulum Lengths and Periods

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

A group of students is attempting to determine the mathematical relationship between the length of a pendulum and its period (one complete swing of a pendulum). The group makes a simple pendulum from string and washers and then suspends it from the ceiling. They record the pendulum's period for each of 12 string lengths.*

Length (cm)	Time (sec)	Length (cm)	Time (sec)
6.5	0.51	24.4	1.01
11.0	0.68	26.6	1.08
13.2	0.73	30.5	1.13
15.0	0.79	34.3	1.26
18.0	0.88	37.6	1.28
23.1	0.99	41.5	1.32

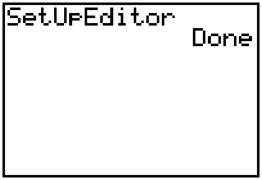
*This example is quoted and adapted from *Contemporary Precalculus Through Applications*, by the North Carolina School of Science and Mathematics, by permission of Janson Publications, Inc., Dedham, MA. 1-800-322-MATH. © 1992. All rights reserved.

1. Press MODE ▼ ▼ ▼ ENTER to set **Func** graphing mode.

2. Press STAT **5** to select **5:SetUpEditor**. **SetUpEditor** is pasted to the home screen.

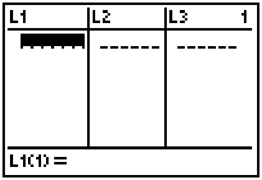
   Press ENTER. This removes lists from stat list editor columns 1 through 20, and then stores lists **L1** through **L6** in columns 1 through 6.

   Note: Removing lists from the stat list editor does not delete them from memory.



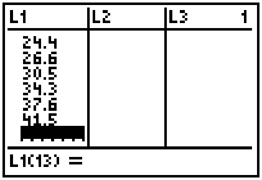
```
SetUpEditor
               Done
```

3. Press STAT **1** to select **1:Edit** from the **STAT EDIT** menu. The stat list editor is displayed. If elements are stored in **L1** and **L2**, press ▲ to move the cursor onto **L1**, and then press CLEAR ENTER ► ▲ CLEAR ENTER to clear both lists. Press ◄ to move the rectangular cursor back to the first row in **L1**.



```
L1      L2      L3     1
------  ------  ------
L1(1)=
```

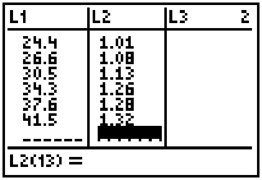
4. Press **6** . **5** ENTER to store the first pendulum string length (6.5 cm) in **L1**. The rectangular cursor moves to the next row. Repeat this step to enter each of the 12 string length values in the table.



```
L1      L2      L3     1
 24.4
 26.6
 30.5
 34.3
 37.6
 41.5
------
L1(13) =
```

5. Press ► to move the rectangular cursor to the first row in **L2**.

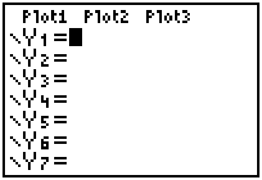
   Press . **51** ENTER to store the first time measurement (.51 sec) in **L2**. The rectangular cursor moves to the next row. Repeat this step to enter each of the 12 time values in the table.



```
L1      L2      L3     2
 24.4    1.01
 26.6    1.08
 30.5    1.13
 34.3    1.26
 37.6    1.28
 41.5    1.32
------  ------
L2(13) =
```

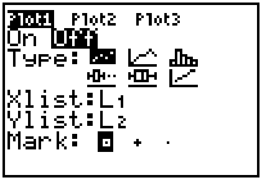
6. Press [Y=] to display the Y= editor.

   If necessary, press [CLEAR] to clear the function **Y1**. As necessary, press [▲], [ENTER], and [▶] to turn off **Plot1**, **Plot2**, and **Plot3** from the top line of the Y= editor (Chapter 3). As necessary, press [▼], [◀], and [ENTER] to deselect functions.



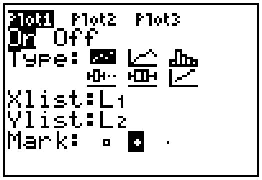
```
 Plot1  Plot2  Plot3
\Y1=■
\Y2=
\Y3=
\Y4=
\Y5=
\Y6=
\Y7=
```

7. Press [2nd] [STAT PLOT] **1** to select **1:Plot1** from the **STAT PLOTS** menu. The stat plot editor is displayed for plot 1.



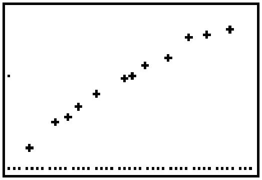
```
Plot1  Plot2  Plot3
On Off
Type:
Xlist:L1
Ylist:L2
Mark: □ + ·
```

8. Press [ENTER] to select **On**, which turns on plot 1. Press [▼] [ENTER] to select ⋰ (scatter plot). Press [▼] [2nd] [L1] to specify **Xlist:L1** for plot 1. Press [▼] [2nd] [L2] to specify **Ylist:L2** for plot 1. Press [▼] [▶] [ENTER] to select **+** as the **Mark** for each data point on the scatter plot.



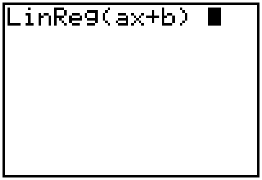
```
Plot1  Plot2  Plot3
On Off
Type:
Xlist:L1
Ylist:L2
Mark: □ + ·
```

9. Press [ZOOM] **9** to select **9:ZoomStat** from the **ZOOM** menu. The window variables are adjusted automatically, and plot 1 is displayed. This is a scatter plot of the time-versus-length data.



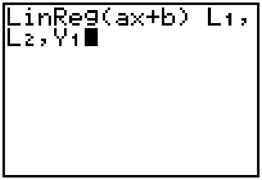
Since the scatter plot of time-versus-length data appears to be approximately linear, fit a line to the data.

10. Press STAT ▸ **4** to select **4:LinReg(ax+b)** (linear regression model) from the **STAT CALC** menu. **LinReg(ax+b)** is pasted to the home screen.



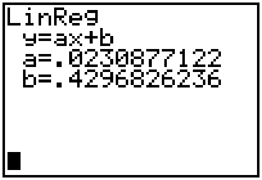
```
LinReg(ax+b) █
```

11. Press 2nd [L1] , 2nd [L2] ,. Press VARS ▸ **1** to display the **VARS Y-VARS FUNCTION** secondary menu, and then press **1** to select **1:Y1**. **L1**, **L2**, and **Y1** are pasted to the home screen as arguments to **LinReg(ax+b)**.



```
LinReg(ax+b) L1,
L2,Y1█
```

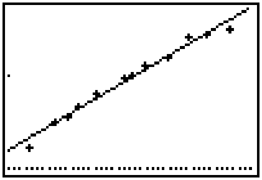
12. Press ENTER to execute **LinReg(ax+b)**. The linear regression for the data in **L1** and **L2** is calculated. Values for **a** and **b** are displayed on the home screen. The linear regression equation is stored in **Y1**. Residuals are calculated and stored automatically in the list name **RESID**, which becomes an item on the **LIST NAMES** menu.



```
LinReg
 y=ax+b
 a=.0230877122
 b=.4296826236

█
```

13. Press GRAPH. The regression line and the scatter plot are displayed.

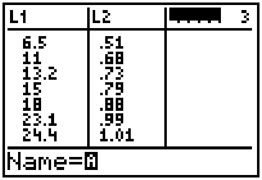


The regression line appears to fit the central portion of the scatter plot well. However, a residual plot may provide more information about this fit.

14. Press STAT **1** to select **1:Edit**. The stat list editor is displayed.

    Press ▶ and ▲ to move the cursor onto **L3**.

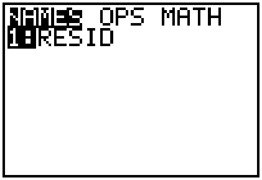
    Press 2nd [INS]. An unnamed column is displayed in column 3; **L3**, **L4**, **L5**, and **L6** shift right one column. The **Name=** prompt is displayed in the entry line, and alpha-lock is on.



```
L1       L2               3
 6.5      .51
 11       .68
 13.2     .73
 15       .79
 18       .88
 23.1     .99
 24.4     1.01
Name=A
```

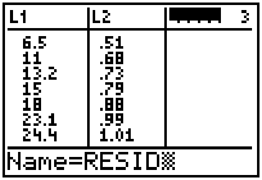
15. Press 2nd [LIST] to display the **LIST NAMES** menu.

    If necessary, press ▼ to move the cursor onto the list name **RESID**.



```
NAMES OPS MATH
1:RESID
```

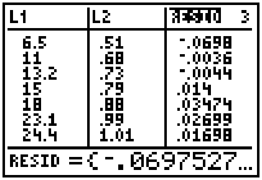
16. Press ENTER to select **RESID** and paste it to the stat list editor's **Name=** prompt.



```
L1       L2               3
 6.5      .51
 11       .68
 13.2     .73
 15       .79
 18       .88
 23.1     .99
 24.4     1.01
Name=RESID
```

17. Press ENTER. **RESID** is stored in column 3 of the stat list editor.

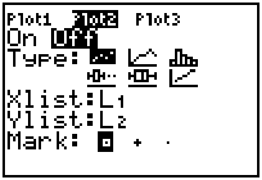
    Press ▼ repeatedly to examine the residuals.



```
L1       L2       RESID   3
 6.5      .51     ⁻.0698
 11       .68     ⁻.0036
 13.2     .73     ⁻.0044
 15       .79     .014
 18       .88     .03474
 23.1     .99     .02699
 24.4     1.01    .01698
RESID ={⁻.0697527…
```

Notice that the first three residuals are negative. They correspond to the shortest pendulum string lengths in **L1**. The next five residuals are positive, and three of the last four are negative. The latter correspond to the longer string lengths in **L1**. Plotting the residuals will show this pattern more clearly.

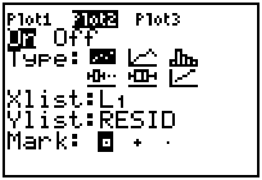
18. Press [2nd] [STAT PLOT] **2** to select **2:Plot2** from the **STAT PLOTS** menu. The stat plot editor is displayed for plot 2.



```
Plot1 Plot2 Plot3
On Off
Type:
Xlist:L1
Ylist:L2
Mark: □ + ·
```

19. Press [ENTER] to select **On**, which turns on plot 2.

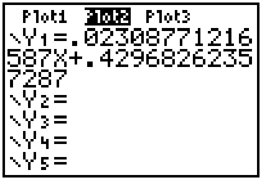
    Press [▼] [ENTER] to select ⋰ (scatter plot). Press [▼] [2nd] [L1] to specify **Xlist:L1** for plot 2. Press [▼] [**R**] [**E**] [**S**] [**I**] [**D**] (alpha-lock is on) to specify **Ylist:RESID** for plot 2. Press [▼] [ENTER] to select □ as the mark for each data point on the scatter plot.



```
Plot1 Plot2 Plot3
On Off
Type:
Xlist:L1
Ylist:RESID
Mark: □ + ·
```

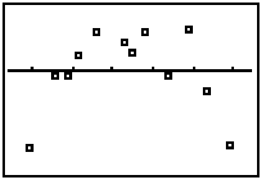
20. Press [Y=] to display the Y= editor.

    Press [◀] to move the cursor onto the **=** sign, and then press [ENTER] to deselect **Y1**. Press [▲] [ENTER] to turn off plot 1.



```
 Plot1 Plot2 Plot3
\Y1=.02308771216
587X+.4296826235
7287
\Y2=
\Y3=
\Y4=
\Y5=
```

21. Press [ZOOM] **9** to select **9:ZoomStat** from the **ZOOM** menu. The window variables are adjusted automatically, and plot 2 is displayed. This is a scatter plot of the residuals.

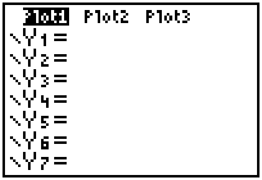


Notice the pattern of the residuals: a group of negative residuals, then a group of positive residuals, and then another group of negative residuals.

The residual pattern indicates a curvature associated with this data set for which the linear model did not account. The residual plot emphasizes a downward curvature, so a model that curves down with the data would be more accurate. Perhaps a function such as square root would fit. Try a power regression to fit a function of the form $y = a * x^b$.

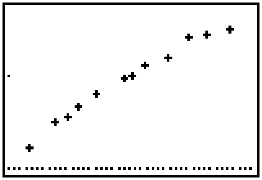
22. Press Y= to display the Y= editor.

    Press CLEAR to clear the linear regression equation from **Y1**. Press ▲ ENTER to turn on plot 1. Press ► ENTER to turn off plot 2.



```
Plot1 Plot2 Plot3
\Y1=
\Y2=
\Y3=
\Y4=
\Y5=
\Y6=
\Y7=
```

23. Press ZOOM **9** to select **9:ZoomStat** from the **ZOOM** menu. The window variables are adjusted automatically, and the original scatter plot of time-versus-length data (plot 1) is displayed.

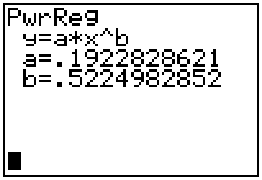


24. Press STAT ► ALPHA [**A**] to select **A:PwrReg** from the **STAT CALC** menu. **PwrReg** is pasted to the home screen.

    Press 2nd [L1] , 2nd [L2] ,. Press VARS ► **1** to display the **VARS Y-VARS FUNCTION** secondary menu, and then press **1** to select **1:Y1**. **L1**, **L2**, and **Y1** are pasted to the home screen as arguments to **PwrReg**.

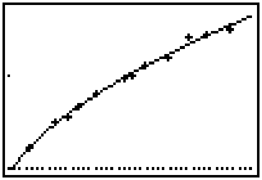
```
PwrReg L1,L2,Y1
```

25. Press ENTER to calculate the power regression. Values for **a** and **b** are displayed on the home screen. The power regression equation is stored in **Y1**. Residuals are calculated and stored automatically in the list name **RESID**.



```
PwrReg
 y=a*x^b
 a=.1922828621
 b=.5224982852
```

26. Press GRAPH. The regression line and the scatter plot are displayed.



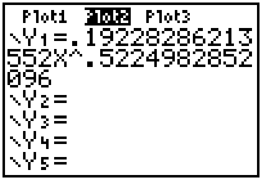
The new function $y=.192x^{.522}$ appears to fit the data well. To get more information, examine a residual plot.

27. Press Y= to display the Y= editor.

    Press ◀ ENTER to deselect **Y1**.

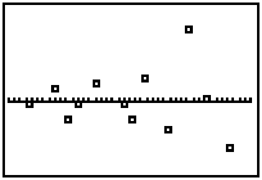
    Press ▲ ENTER to turn off plot 1. Press ▶ ENTER to turn on plot 2.

    Note: Step 19 defined plot 2 to plot residuals (**RESID**) versus string length (**L1**).



```
 Plot1  Plot2  Plot3
\Y1=.19228286213
552X^.5224982852
096
\Y2=
\Y3=
\Y4=
\Y5=
```

28. Press ZOOM **9** to select **9:ZoomStat** from the **ZOOM** menu. The window variables are adjusted automatically, and plot 2 is displayed. This is a scatter plot of the residuals.



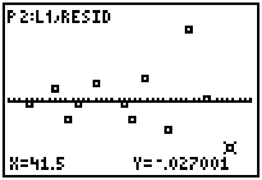
The new residual plot shows that the residuals are random in sign, with the residuals increasing in magnitude as the string length increases.

To see the magnitudes of the residuals, continue with these steps.

29. Press TRACE.

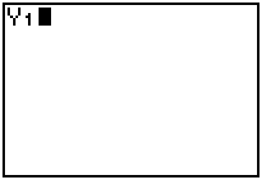
    Press ▸ and ◂ to trace the data. Observe the values for Y at each point.

    With this model, the largest positive residual is about 0.041 and the smallest negative residual is about ⁻0.027. All other residuals are less than 0.02 in magnitude.



Now that you have a good model for the relationship between length and period, you can use the model to predict the period for a given string length. To predict the periods for a pendulum with string lengths of 20 cm and 50 cm, continue with these steps.

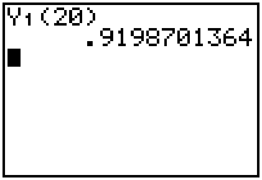
30. Press VARS ▸ **1** to display the **VARS Y-VARS FUNCTION** secondary menu, and then press **1** to select **1:Y1**. **Y1** is pasted to the home screen.



31. Press [(] **20** [)] to enter a string length of 20 cm.

    Press [ENTER] to calculate the predicted time of about 0.92 seconds.

    Based on the residual analysis, we would expect the prediction of about 0.92 seconds to be within about 0.02 seconds of the actual value.



```
Y1(20)
      .9198701364
█
```

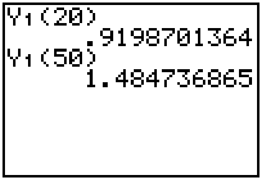
32. Press [2nd] [ENTRY] to recall the Last Entry.

    Press [◄] [◄] [◄] **5** to change the string length to 50 cm.

33. Press [ENTER] to calculate the predicted time of about 1.48 seconds.

    Since a string length of 50 cm exceeds the lengths in the data set, and since residuals appear to be increasing as string length increases, we would expect more error with this estimate.

    Note: You also can make predictions using the table with the **TABLE SETUP** settings **Indpnt:Ask** and **Depend:Auto** (Chapter 7).



```
Y1(20)
      .9198701364
Y1(50)
       1.484736865
```

Setting Up Statistical Analyses

Using Lists to Store Data

Data for statistical analyses is stored in lists, which you can create and edit using the stat list editor. The TI-84 Plus has six list variables in memory, **L1** through **L6**, to which you can store data for statistical calculations. Also, you can store data to list names that you create (Chapter 11).

Setting Up a Statistical Analysis

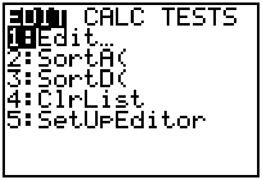
To set up a statistical analysis, follow these steps. Read the chapter for details.

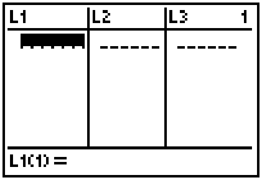
1. Enter the statistical data into one or more lists.
2. Plot the data.
3. Calculate the statistical variables or fit a model to the data.
4. Graph the regression equation for the plotted data.
5. Graph the residuals list for the given regression model.

Displaying the Stat List Editor

The stat list editor is a table where you can store, edit, and view up to 20 lists that are in memory. Also, you can create list names from the stat list editor.

To display the stat list editor, press STAT, and then select **1:Edit** from the **STAT EDIT** menu.





The top line displays list names. **L1** through **L6** are stored in columns 1 through 6 after a memory reset. The number of the current column is displayed in the top-right corner.

The bottom line is the entry line. All data entry occurs on this line. The characteristics of this line change according to the current context.

The center area displays up to seven elements of up to three lists; it abbreviates values when necessary. The entry line displays the full value of the current element.

Using the Stat List Editor

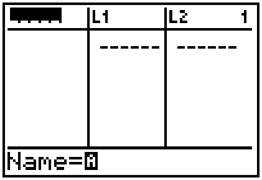
Entering a List Name in the Stat List Editor

To enter a list name in the stat list editor, follow these steps.

1. Display the **Name=** prompt in the entry line in either of two ways.
   - Move the cursor onto the list name in the column where you want to insert a list, and then press [2nd] [INS]. An unnamed column is displayed and the remaining lists shift right one column.
   - Press ▲ until the cursor is on the top line, and then press ▶ until you reach the unnamed column.

   Note: If list names are stored to all 20 columns, you must remove a list name to make room for an unnamed column.

   The **Name=** prompt is displayed and alpha-lock is on.

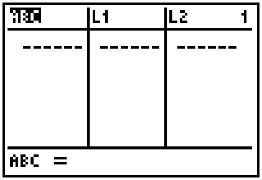


```
      L1      L2      1
      ------  ------
Name=
```

2. Enter a valid list name in any of four ways.
   - Select a name from the **LIST NAMES** menu (Chapter 11).
   - Enter **L1**, **L2**, **L3**, **L4**, **L5**, or **L6** from the keyboard.
   - Enter an existing user-created list name directly from the keyboard.
   - Enter a new user-created list name.

```
Name=ABC
```

3. Press [ENTER] or [▾] to store the list name and its elements, if any, in the current column of the stat list editor.



To begin entering, scrolling, or editing list elements, press ▼. The rectangular cursor is displayed.

Note: If the list name you entered in step 2 already was stored in another stat list editor column, then the list and its elements, if any, move to the current column from the previous column. Remaining list names shift accordingly.

Creating a Name in the Stat List Editor

To create a name in the stat list editor, follow these steps.

1. Display the **Name=** prompt.
2. Press [*letter from A to Z or* θ] to enter the first letter of the name. The first character cannot be a number.
3. Enter zero to four letters, θ, or numbers to complete the new user-created list name. List names can be one to five characters long.
4. Press ENTER or ▼ to store the list name in the current column of the stat list editor. The list name becomes an item on the **LIST NAMES** menu (Chapter 11).

Removing a List from the Stat List Editor

To remove a list from the stat list editor, move the cursor onto the list name and then press DEL. The list is not deleted from memory; it is only removed from the stat list editor.

Notes:

- To delete a list name from memory, use the **MEMORY MANAGEMENT/DELETE** secondary menu (Chapter 18).

- If you archive a list, it will be removed from the stat list editor.

Removing All Lists and Restoring L1 through L6

You can remove all user-created lists from the stat list editor and restore list names **L1** through **L6** to columns 1 through 6 in either of two ways.

- Use **SetUpEditor** with no arguments.
- Reset all memory (Chapter 18).

Clearing All Elements from a List

You can clear all elements from a list in any of five ways.

- Use **ClrList** to clear specified lists.
- In the stat list editor, press ▲ to move the cursor onto a list name, and then press CLEAR ENTER.
- In the stat list editor, move the cursor onto each element, and then press DEL one by one.

- On the home screen or in the program editor, enter **0→dim(***listname***)** to set the dimension of *listname* to 0 (Chapter 11).
- Use **ClrAllLists** to clear all lists in memory (Chapter 18).

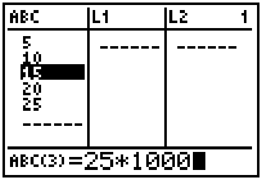
Editing a List Element

To edit a list element, follow these steps.

1. Move the rectangular cursor onto the element you want to edit.
2. Press [ENTER] to move the cursor to the entry line.

   Note: If you want to replace the current value, you can enter a new value without first pressing [ENTER]. When you enter the first character, the current value is cleared automatically.
3. Edit the element in the entry line.
   - Press one or more keys to enter the new value. When you enter the first character, the current value is cleared automatically.
   - Press [▸] to move the cursor to the character before which you want to insert, press [2nd] [INS], and then enter one or more characters.
   - Press [▸] to move the cursor to a character you want to delete, and then press [DEL] to delete the character.

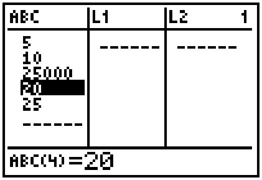
   To cancel any editing and restore the original element at the rectangular cursor, press [CLEAR] [ENTER].



```
ABC    L1     L2     1
 5     ------ ------
 10
 15
 20
 25
 ------
ABC(3)=25*1000
```

Note: You can enter expressions and variables for elements.

4. Press [ENTER], [▲], or [▼] to update the list. If you entered an expression, it is evaluated. If you entered only a variable, the stored value is displayed as a list element.



```
ABC    L1     L2     1
 5     ------ ------
 10
 25000
 20
 25
 ------
ABC(4)=20
```

When you edit a list element in the stat list editor, the list is updated in memory immediately.

Attaching Formulas to List Names

Attaching a Formula to a List Name in Stat List Editor

You can attach a formula to a list name in the stat list editor, and then display and edit the calculated list elements. When executed, the attached formula must resolve to a list. Chapter 11 describes in detail the concept of attaching formulas to list names.

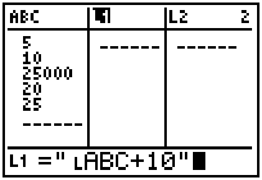
To attach a formula to a list name that is stored in the stat list editor, follow these steps.

1. Press STAT ENTER to display the stat list editor.
2. Press ▲ to move the cursor to the top line.
3. Press ◀ or ▶, if necessary, to move the cursor onto the list name to which you want to attach the formula.

   Note: If a formula in quotation marks is displayed on the entry line, then a formula is already attached to the list name. To edit the formula, press ENTER, and then edit the formula.

4. Press ALPHA ["], enter the formula, and press ALPHA ["].

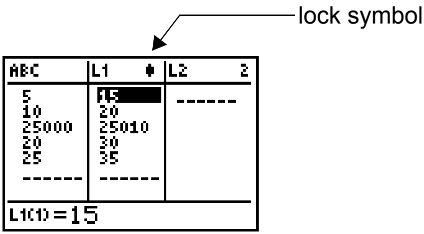
   Note: If you do not use quotation marks, the TI-84 Plus calculates and displays the same initial list of answers, but does not attach the formula for future calculations.



```
ABC    | L1    | L2     2
 5     | ------| ------
 10    |       |
 25000 |       |
 20    |       |
 25    |       |
 ------|       |
L1 ="ʟABC+10"
```

   Note: Any user-created list name referenced in a formula must be preceded by an ʟ symbol (Chapter 11).

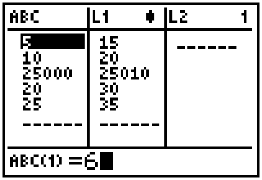
5. Press ENTER. The TI-84 Plus calculates each list element and stores it to the list name to which the formula is attached. A lock symbol is displayed in the stat list editor, next to the list name to which the formula is attached.



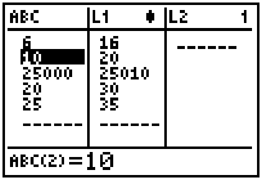
```
ABC    |L1   🔒|L2     2
 5     |15     | ------
 10    |20     |
 25000 |25010  |
 20    |30     |
 25    |35     |
 ------| ------|
L1(1)=15
```

Using the Stat List Editor When Formula-Generated Lists Are Displayed

When you edit an element of a list referenced in an attached formula, the TI-84 Plus updates the corresponding element in the list to which the formula is attached (Chapter 11).



```
ABC    |L1   🔒|L2     1
 5     |15     | ------
 10    |20     |
 25000 |25010  |
 20    |30     |
 25    |35     |
 ------| ------|
ABC(1)=6
```



```
ABC    |L1   🔒|L2     1
 6     |16     | ------
 10    |20     |
 25000 |25010  |
 20    |30     |
 25    |35     |
 ------| ------|
ABC(2)=10
```

When a list with a formula attached is displayed in the stat list editor and you edit or enter elements of another displayed list, then the TI-84 Plus takes slightly longer to accept each edit or entry than when no lists with formulas attached are in view.

Note: To speed editing time, scroll horizontally until no lists with formulas are displayed, or rearrange the stat list editor so that no lists with formulas are displayed.

Handling Errors Resulting from Attached Formulas

On the home screen, you can attach to a list a formula that references another list with dimension 0 (Chapter 11). However, you cannot display the formula-generated list in the stat list editor or on the home screen until you enter at least one element to the list that the formula references.

All elements of a list referenced by an attached formula must be valid for the attached formula. For example, if **Real** number mode is set and the attached formula is **log(L1)**, then each element of **L1** must be greater than 0, since the logarithm of a negative number returns a complex result.

Notes:

- If an error menu is returned when you attempt to display a formula-generated list in the stat list editor, you can select **2:Goto**, write down the formula that is attached to the list, and then press [CLEAR] [ENTER] to detach (clear) the formula. You then can use the stat list editor to find the source of the error. After making the appropriate changes, you can reattach the formula to a list.

- If you do not want to clear the formula, you can select **1:Quit**, display the referenced list on the home screen, and find and edit the source of the error. To edit an element of a list on the home screen, store the new value to *listname***(***element#***)** (Chapter 11).

Detaching Formulas from List Names

Detaching a Formula from a List Name

You can detach (clear) a formula from a list name in several ways.

For example:

- In the stat list editor, move the cursor onto the name of the list to which a formula is attached. Press ENTER CLEAR ENTER. All list elements remain, but the formula is detached and the lock symbol disappears.
- In the stat list editor, move the cursor onto an element of the list to which a formula is attached. Press ENTER, edit the element, and then press ENTER. The element changes, the formula is detached, and the lock symbol disappears. All other list elements remain.
- Use **ClrList**. All elements of one or more specified lists are cleared, each formula is detached, and each lock symbol disappears. All list names remain.
- Use **ClrAllLists** (Chapter 18). All elements of all lists in memory are cleared, all formulas are detached from all list names, and all lock symbols disappear. All list names remain.

Editing an Element of a Formula-Generated List

As described above, one way to detach a formula from a list name is to edit an element of the list to which the formula is attached. The TI-84 Plus protects against inadvertently detaching the formula from the list name by editing an element of the formula-generated list.

Because of the protection feature, you must press ENTER before you can edit an element of a formula-generated list.

The protection feature does not allow you to delete an element of a list to which a formula is attached. To delete an element of a list to which a formula is attached, you must first detach the formula in any of the ways described above.

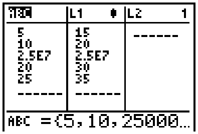
Switching Stat List Editor Contexts

Stat List Editor Contexts

The stat list editor has four contexts.

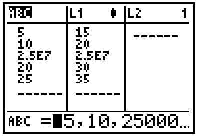
- View-elements context
- View-names context
- Edit-elements context
- Enter-name context

The stat list editor is first displayed in view-elements context. To switch through the four contexts, select **1:Edit** from the **STAT EDIT** menu and follow these steps.



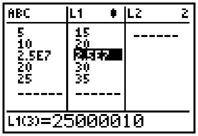
```
ABC    |L1    ◆|L2    1
 5     | 15    | ------
 10    | 20    |
 2.5E7 | 2.5E7 |
 20    | 30    |
 25    | 35    |
 ------| ------|
ABC ={5,10,25000…
```

1. Press ▲ to move the cursor onto a list name. You are now in view-names context. Press ▶ and ◀ to view list names stored in other stat list editor columns.



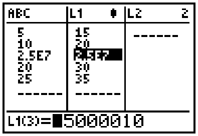
```
ABC    |L1    ◆|L2    1
 5     | 15    | ------
 10    | 20    |
 2.5E7 | 2.5E7 |
 20    | 30    |
 25    | 35    |
 ------| ------|
ABC =█5,10,25000…
```

2. Press [ENTER]. You are now in edit-elements context. You may edit any element in a list. All elements of the current list are displayed in braces (**{ }**)in the entry line. Press ▶ and ◀ to view more list elements.



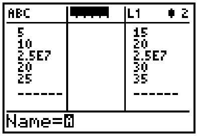
```
ABC    |L1    ◆|L2    2
 5     | 15    | ------
 10    | 20    |
 2.5E7 | 2.5E7 |
 20    | 30    |
 25    | 35    |
 ------| ------|
L1(3)=25000010
```

3. Press [ENTER] again. You are now in view-elements context. Press ▶, ◀, ▼, and ▲ to view other list elements. The current element's full value is displayed in the entry line.



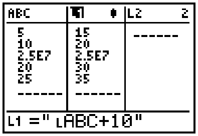
```
ABC     L1      ♦ L2      2
5       15        ------
10      20
2.5E7   2.5E7
20      30
25      35
------  ------
L1(3)=5000010
```

4. Press [ENTER] again. You are now in edit-elements context. You may edit the current element in the entry line.



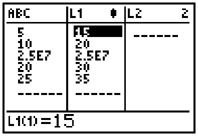
```
ABC     ------  L1      ♦ 2
5               15
10              20
2.5E7           2.5E7
20              30
25              35
------          ------
Name=
```

5. Press [▲] until the cursor is on a list name, then press [2nd] [INS]. You are now in enter-name context.



```
ABC     L1      ♦ L2      2
5       15        ------
10      20
2.5E7   2.5E7
20      30
25      35
------  ------
L1 =" ʟABC+10"
```

6. Press [CLEAR]. You are now in view-names context.



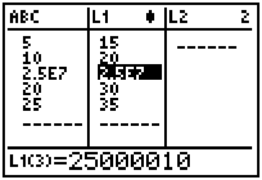
```
ABC     L1      ♦ L2      2
5       15        ------
10      20
2.5E7   2.5E7
20      30
25      35
------  ------
L1(1)=15
```

7. Press [▼]. You are now back in view-elements context.

Stat List Editor Contexts

View-Elements Context

In view-elements context, the entry line displays the list name, the current element's place in that list, and the full value of the current element, up to 12 characters at a time. An ellipsis (...) indicates that the element continues beyond 12 characters.



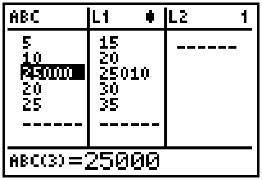
```
ABC     L1     ♦ L2      2
 5       15      ------
 10      20
 2.5E7   2.5E7
 20      30
 25      35
 ------  ------
L1(3)=25000010
```

To page down the list six elements, press ALPHA ▼. To page up six elements, press ALPHA ▲. To delete a list element, press DEL. Remaining elements shift up one row. To insert a new element, press 2nd [INS]. **0** is the default value for a new element.

Edit-Elements Context

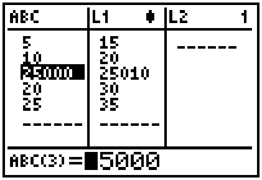
In edit-elements context, the data displayed in the entry line depends on the previous context.

- When you switch to edit-elements context from view-elements context, the full value of the current element is displayed. You can edit the value of this element, and then press ▼ and ▲ to edit other list elements.



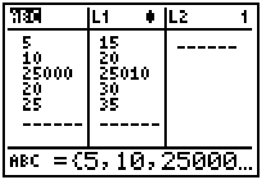
```
ABC     L1     ♦ L2      1
 5       15      ------
 10      20
 25000   25010
 20      30
 25      35
 ------  ------
ABC(3)=25000
```

→

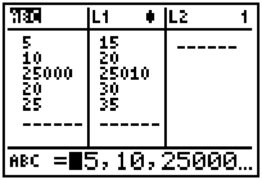


```
ABC     L1     ♦ L2      1
 5       15      ------
 10      20
 25000   25010
 20      30
 25      35
 ------  ------
ABC(3)=█5000
```

- When you switch to edit-elements context from view-names context, the full values of all elements in the list are displayed. An ellipsis indicates that list elements continue beyond the screen. You can press ▶ and ◀ to edit any element in the list.



```
ABC     L1     ♦ L2      1
 5       15      ------
 10      20
 25000   25010
 20      30
 25      35
 ------  ------
ABC ={5,10,25000…
```

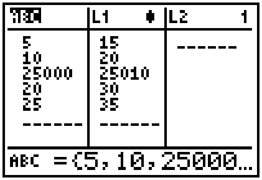


```
ABC     L1     ♦ L2      1
 5       15      ------
 10      20
 25000   25010
 20      30
 25      35
 ------  ------
ABC =█5,10,25000…
```

Note: In edit-elements context, you can attach a formula to a list name only if you switched to it from view-names context.

View-Names Context

In view-names context, the entry line displays the list name and the list elements.



```
ABC     L1     ♦ L2      1
 5       15      ------
 10      20
 25000   25010
 20      30
 25      35
 ------  ------
ABC ={5,10,25000…
```

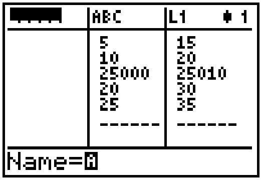
To remove a list from the stat list editor, press DEL. Remaining lists shift to the left one column. The list is not deleted from memory.

To insert a name in the current column, press 2nd [INS]. Remaining columns shift to the right one column.

Enter-Name Context

In enter-name context, the **Name=** prompt is displayed in the entry line, and alpha-lock is on.

At the **Name=** prompt, you can create a new list name, paste a list name from **L1** to **L6** from the keyboard, or paste an existing list name from the **LIST NAMES** menu (Chapter 11). The **L** symbol is not required at the **Name=** prompt.



```
      |ABC    |L1    ♦ 1
      |5      |15
      |10     |20
      |25000  |25010
      |20     |30
      |25     |35
      |------ |------
Name=A
```

To leave enter-name context without entering a list name, press `CLEAR`. The stat list editor switches to view-names context.

STAT EDIT Menu

STAT EDIT Menu

To display the **STAT EDIT** menu, press STAT.

`EDIT  CALC TESTS`	
`1: Edit...`	Displays the stat list editor.
`2: SortA(`	Sorts a list in ascending order.
`3: SortD(`	Sorts a list in descending order.
`4: ClrList`	Deletes all elements of a list.
`5: SetUpEditor`	Stores specified lists in the stat list editor.

Note: Chapter 13: Inferential Statistics describes the **STAT TESTS** menu items.

SortA(, SortD(

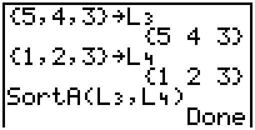
SortA((sort ascending) sorts list elements from low to high values. **SortD(** (sort descending) sorts list elements from high to low values. Complex lists are sorted based on magnitude (modulus). **SortA(** and **SortD(** each can sort in either of two ways.

- With one *listname*, **SortA(** and **SortD(** sort the elements in *listname* and update the list in memory.
- With two or more lists, **SortA(** and **SortD(** sort *keylistname*, and then sort each *dependlist* by placing its elements in the same order as the corresponding elements in

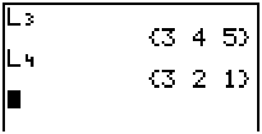
keylistname. This lets you sort two-variable data on X and keep the data pairs together. All lists must have the same dimension.

The sorted lists are updated in memory.

SortA(*listname***)**
SortD(*listname***)**
SortA(*keylistname***,***dependlist1*[**,***dependlist2***,...,***dependlist n*]**)**
SortD(*keylistname***,***dependlist1*[**,***dependlist2***,...,***dependlist n*]**)**



```
{5,4,3}→L₃
           {5 4 3}
{1,2,3}→L₄
           {1 2 3}
SortA(L₃,L₄)
              Done
```



```
L₃
           {3 4 5}
L₄
           {3 2 1}
```

Note: SortA(and **SortD(** are the same as **SortA(** and **SortD(** on the **LIST OPS** menu.

ClrList

ClrList clears (deletes) from memory the elements of one or more *listnames*. **ClrList** also detaches any formula attached to a *listname*.

ClrList *listname1***,***listname2***,...,***listname n*

Note: To clear from memory all elements of all list names, use **ClrAllLists** (Chapter 18).

SetUpEditor

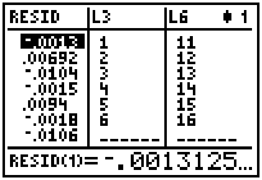
With **SetUpEditor** you can set up the stat list editor to display one or more *listnames* in the order that you specify. You can specify zero to 20 *listnames*.

Additionally, if you want to use *listnames* which happen to be archived, the SetUp Editor will automatically unarchive the *listnames* and place them in the stat list editor at the same time.

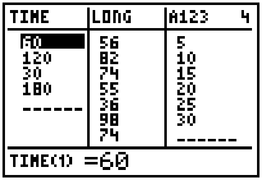
SetUpEditor [*listname1*,*listname2*,...,*listname n*]

SetUpEditor with one to 20 *listnames* removes all list names from the stat list editor and then stores *listnames* in the stat list editor columns in the specified order, beginning in column 1.

```
SetUpEditor RESI
D,L3,L6,TIME,LON
G,A123
            Done
```



```
RESID   |L3     |L6    ♦ 1
 -.0013 | 1     | 11
.00692  | 2     | 12
 -.0104 | 3     | 13
 -.0015 | 4     | 14
.0094   | 5     | 15
 -.0018 | 6     | 16
 -.0106 | ------| ------
RESID(1)=-.0013125...
```



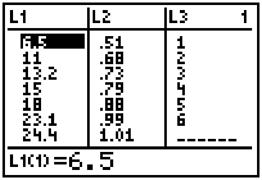
```
TIME    |LONG   |A123    4
 60     | 56    | 5
 120    | 82    | 10
 30     | 74    | 15
 180    | 55    | 20
 ------ | 36    | 25
        | 98    | 30
        | 74    | ------
TIME(1) =60
```

If you enter a *listname* that is not stored in memory already, then *listname* is created and stored in memory; it becomes an item on the **LIST NAMES** menu.

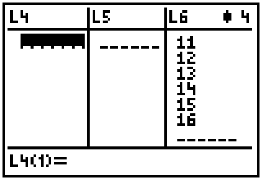
Restoring L1 through L6 to the Stat List Editor

SetUpEditor with no *listnames* removes all list names from the stat list editor and restores list names **L1** through **L6** in the stat list editor columns 1 through 6.

```
SetUpEditor
             Done
```



```
L1      L2     L3       1
 6.5     .51    1
 11      .68    2
 13.2    .73    3
 15      .79    4
 18      .88    5
 23.1    .99    6
 24.4   1.01    ------
L1(1)=6.5
```



```
L4      L5      L6     ♦ 4
 ------  ------  11
                 12
                 13
                 14
                 15
                 16
                 ------
L4(1)=
```

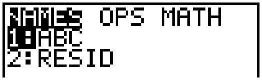
Regression Model Features

Regression Model Features

STAT CALC menu items **3** through **C** are regression models. The automatic residual list and automatic regression equation features apply to all regression models. Diagnostics display mode applies to some regression models.

Automatic Residual List

When you execute a regression model, the automatic residual list feature computes and stores the residuals to the list name RESID. RESID becomes an item on the **LIST NAMES** menu (Chapter 11).

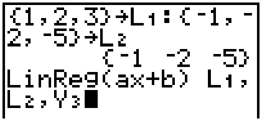


The TI-84 Plus uses the formula below to compute RESID list elements. The next section describes the variable **RegEQ**.

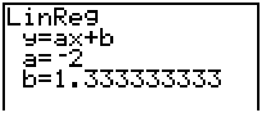
RESID = *Ylistname* − **RegEQ(***Xlistname***)**

Automatic Regression Equation

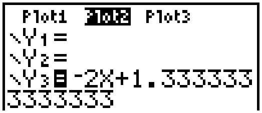
Each regression model has an optional argument, *regequ*, for which you can specify a Y= variable such as **Y1**. Upon execution, the regression equation is stored automatically to the specified Y= variable and the Y= function is selected.



```
{1,2,3}→L₁:{⁻1,⁻
2,⁻5}→L₂
      {⁻1 ⁻2 ⁻5}
LinReg(ax+b) L₁,
L₂,Y₃
```

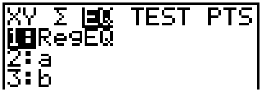


```
LinReg
 y=ax+b
 a=⁻2
 b=1.333333333
```



```
 Plot1 Plot2 Plot3
\Y₁=
\Y₂=
\Y₃=⁻2X+1.333333
3333333
```

Regardless of whether you specify a Y= variable for *regequ*, the regression equation always is stored to the TI-84 Plus variable **RegEQ**, which is item **1** on the **VARS Statistics EQ** secondary menu.



Note: For the regression equation, you can use the fixed-decimal mode setting to control the number of digits stored after the decimal point (Chapter 1). However, limiting the number of digits to a small number could affect the accuracy of the fit.

Diagnostics Display Mode

When you execute some regression models, the TI-84 Plus computes and stores diagnostics values for **r** (correlation coefficient) and **r**^{2} (coefficient of determination) or for **R**^{2} (coefficient of determination).

r and **r**^{2} are computed and stored for these regression models.

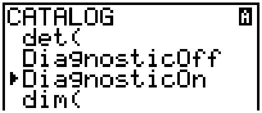
LinReg(ax+b)
LinReg(a+bx)
LnReg
ExpReg
PwrReg

R^2 is computed and stored for these regression models.

QuadReg
CubicReg
QuartReg

The **r** and **r**^{2} that are computed for **LnReg**, **ExpReg**, and **PwrReg** are based on the linearly transformed data. For example, for **ExpReg** (y=ab^x), **r** and **r**^{2} are computed on ln y=ln a+x(ln b).

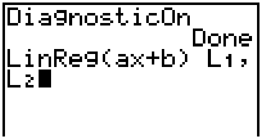
By default, these values are not displayed with the results of a regression model when you execute it. However, you can set the diagnostics display mode by executing the **DiagnosticOn** or **DiagnosticOff** instruction. Each instruction is in the CATALOG (Chapter 15).



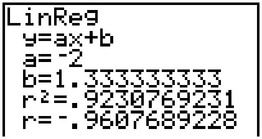
```
CATALOG        A
 det(
 DiagnosticOff
▸DiagnosticOn
 dim(
```

Note: To set **DiagnosticOn** or **DiagnosticOff** from the home screen, press 2nd [CATALOG], and then select the instruction for the mode you want. The instruction is pasted to the home screen. Press ENTER to set the mode.

When **DiagnosticOn** is set, diagnostics are displayed with the results when you execute a regression model.

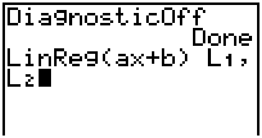


```
DiagnosticOn
            Done
LinReg(ax+b) L₁,
L₂█
```

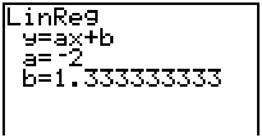


```
LinReg
 y=ax+b
 a=⁻2
 b=1.333333333
 r²=.9230769231
 r=⁻.9607689228
```

When **DiagnosticOff** is set, diagnostics are not displayed with the results when you execute a regression model.



```
DiagnosticOff
            Done
LinReg(ax+b) L₁,
L₂█
```



```
LinReg
 y=ax+b
 a=⁻2
 b=1.333333333
```

STAT CALC Menu

STAT CALC Menu

To display the **STAT CALC** menu, press [STAT] [▶].

`EDIT CALC TESTS`	
`1: 1-Var Stats`	Calculates 1-variable statistics.
`2: 2-Var Stats`	Calculates 2-variable statistics.
`3: Med-Med`	Calculates a median-median line.
`4: LinReg(ax+b)`	Fits a linear model to data.
`5: QuadReg`	Fits a quadratic model to data.
`6: CubicReg`	Fits a cubic model to data.
`7: QuartReg`	Fits a quartic model to data.
`8: LinReg(a+bx)`	Fits a linear model to data.
`9: LnReg`	Fits a logarithmic model to data.
`0: ExpReg`	Fits an exponential model to data.
`A: PwrReg`	Fits a power model to data.
`B: Logistic`	Fits a logistic model to data.
`C: SinReg`	Fits a sinusoidal model to data.
`D: Manual Linear Fit`	Fits a linear equation interactively to a scatter plot.

For each **STAT CALC** menu item, if neither *Xlistname* nor *Ylistname* is specified, then the default list names are **L1** and **L2**. If you do not specify *freqlist*, then the default is 1 occurrence of each list element.

Frequency of Occurrence for Data Points

For most **STAT CALC** menu items, you can specify a list of data occurrences, or frequencies (*freqlist*).

Each element in *freqlist* indicates how many times the corresponding data point or data pair occurs in the data set you are analyzing.

For example, if **L1={15,12,9,14}** and **ʟFREQ={1,4,1,3}**, then the TI-84 Plus interprets the instruction **1-Var Stats L1**, **ʟFREQ** to mean that 15 occurs once, 12 occurs four times, 9 occurs once, and 14 occurs three times.

Each element in *freqlist* must be ≥ 0, and at least one element must be > 0.

Noninteger *freqlist* elements are valid. This is useful when entering frequencies expressed as percentages or parts that add up to 1. However, if *freqlist* contains noninteger frequencies, **Sx** and **Sy** are undefined; values are not displayed for **Sx** and **Sy** in the statistical results.

1-Var Stats

1-Var Stats (one-variable statistics) analyzes data with one measured variable. Each element in *freqlist* is the frequency of occurrence for each corresponding data point in *Xlistname*. *freqlist* elements must be real numbers > 0.

1-Var Stats [*Xlistname*,*freqlist*]

```
1-Var Stats L1,L
2█
```

2-Var Stats

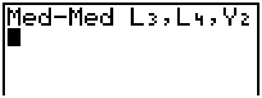
2-Var Stats (two-variable statistics) analyzes paired data. *Xlistname* is the independent variable. *Ylistname* is the dependent variable. Each element in *freqlist* is the frequency of occurrence for each data pair (*Xlistname*,*Ylistname*).

2-Var Stats [*Xlistname*,*Ylistname*,*freqlist*]

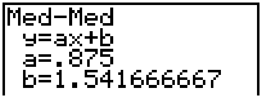
Med-Med (ax+b)

Med-Med (median-median) fits the model equation y=ax+b to the data using the median-median line (resistant line) technique, calculating the summary points x1, y1, x2, y2, x3, and y3. **Med-Med** displays values for **a** (slope) and **b** (y-intercept).

Med-Med [*Xlistname*,*Ylistname*,*freqlist*,*regequ*]



```
Med-Med L3,L4,Y2
█
```



```
Med-Med
 y=ax+b
 a=.875
 b=1.541666667
```

LinReg (ax+b)

LinReg(ax+b) (linear regression) fits the model equation y=ax+b to the data using a least-squares fit. It displays values for **a** (slope) and **b** (y-intercept); when **DiagnosticOn** is set, it also displays values for **r**^{2} and **r**.

LinReg(ax+b) [*Xlistname*,*Ylistname*,*freqlist*,*regequ*]

QuadReg (ax^2+bx+c)

QuadReg (quadratic regression) fits the second-degree polynomial $y=ax^2+bx+c$ to the data. It displays values for **a**, **b**, and **c**; when **DiagnosticOn** is set, it also displays a value for $\mathbf{R}^2$. 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.

QuadReg [*Xlistname*,*Ylistname*,*freqlist*,*regequ*]

CubicReg—(ax^3+bx^2+cx+d)

CubicReg (cubic regression) fits the third-degree polynomial $y=ax^3+bx^2+cx+d$ to the data. It displays values for **a**, **b**, **c**, and **d**; when **DiagnosticOn** is set, it also displays a value for $\mathbf{R}^2$. For four points, the equation is a polynomial fit; for five or more, it is a polynomial regression. At least four points are required.

CubicReg [*Xlistname*,*Ylistname*,*freqlist*,*regequ*]

QuartReg—($ax^4+bx^3+cx^2+ dx+e$)

QuartReg (quartic regression) fits the fourth-degree polynomial $y=ax^4+bx^3+cx^2+dx+e$ to the data. It displays values for **a**, **b**, **c**, **d**, and **e**; when **DiagnosticOn** is set, it also displays a value for $\mathbf{R}^2$. For five points, the equation is a polynomial fit; for six or more, it is a polynomial regression. At least five points are required.

QuartReg [*Xlistname*,*Ylistname*,*freqlist*,*regequ*]

LinReg—(a+bx)

LinReg(a+bx) (linear regression) fits the model equation y=a+bx to the data using a least-squares fit. It displays values for **a** (y-intercept) and **b** (slope); when **DiagnosticOn** is set, it also displays values for $\mathbf{r}^2$ and **r**.

LinReg(a+bx) [*Xlistname*,*Ylistname*,*freqlist*,*regequ*]

LnReg—(a+b ln(x))

LnReg (logarithmic regression) fits the model equation y=a+b ln(x) to the data using a least-squares fit and transformed values ln(x) and y. It displays values for **a** and **b**; when **DiagnosticOn** is set, it also displays values for $\mathbf{r}^2$ and **r**.

LnReg [*Xlistname*,*Ylistname*,*freqlist*,*regequ*]

ExpReg—(ab^x)

ExpReg (exponential regression) fits the model equation $y=ab^x$ to the data using a least-squares fit and transformed values x and ln(y). It displays values for **a** and **b**; when **DiagnosticOn** is set, it also displays values for $\mathbf{r}^2$ and **r**.

ExpReg [*Xlistname*,*Ylistname*,*freqlist*,*regequ*]

PwrReg—(ax^b)

PwrReg (power regression) fits the model equation $y=ax^b$ to the data using a least-squares fit and transformed values ln(x) and ln(y). It displays values for **a** and **b**; when **DiagnosticOn** is set, it also displays values for $\mathbf{r}^2$ and **r**.

PwrReg [*Xlistname*,*Ylistname*,*freqlist*,*regequ*]

Logistic—$c/(1+a*e^{-bx})$

Logistic fits the model equation $y=c/(1+a*e^{-bx})$ to the data using an iterative least-squares fit. It displays values for **a**, **b**, and **c**.

Logistic [*Xlistname*,*Ylistname*,*freqlist*,*regequ*]

SinReg—a sin(bx+c)+d

SinReg (sinusoidal regression) fits the model equation y=a sin(bx+c)+d to the data using an iterative least-squares fit. It displays values for **a**, **b**, **c**, and **d**. At least four data points are required. At least two data points per cycle are required in order to avoid aliased frequency estimates.

SinReg [*iterations*,*Xlistname*,*Ylistname*,*period*,*regequ*]

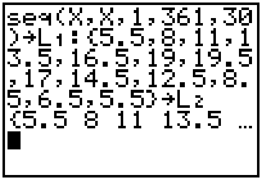
iterations is the maximum number of times the algorithm will iterate to find a solution. The value for *iterations* can be an integer ≥ 1 and ≤ 16; if not specified, the default is 3. The algorithm may find a solution before *iterations* is reached. Typically, larger values for *iterations* result in longer execution times and better accuracy for **SinReg**, and vice versa.

A *period* guess is optional. If you do not specify *period*, the difference between time values in *Xlistname* must be equal and the time values must be ordered in ascending sequential order. If you specify *period*, the algorithm may find a solution more quickly, or it may find a solution when it would not have found one if you had omitted a value for *period*. If you specify *period*, the differences between time values in *Xlistname* can be unequal.

Note: The output of **SinReg** is always in radians, regardless of the Radian/Degree mode setting.

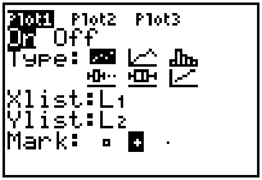
SinReg Example: Daylight Hours in Alaska for One Year

Compute the regression model for the number of hours of daylight in Alaska during one year.

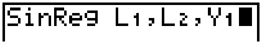


```
seq(X,X,1,361,30
)→L₁:{5.5,8,11,1
3.5,16.5,19,19.5
,17,14.5,12.5,8.
5,6.5,5.5}→L₂
{5.5 8 11 13.5 …
```

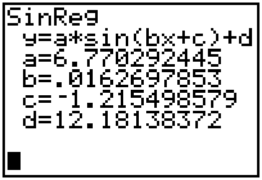
→



```
Plot1 Plot2 Plot3
On Off
Type:
Xlist:L₁
Ylist:L₂
Mark:
```

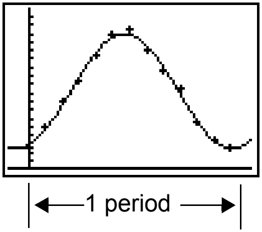


```
SinReg L₁,L₂,Y₁
```



```
SinReg
 y=a*sin(bx+c)+d
 a=6.770292445
 b=.0162697853
 c=-1.215498579
 d=12.18138372
```

→



With noisy data, you will achieve better convergence results when you specify an accurate estimate for *period*. You can obtain a *period* guess in either of two ways.

- Plot the data and trace to determine the x-distance between the beginning and end of one complete period, or cycle. The illustration above and to the right graphically depicts a complete period, or cycle.
- Plot the data and trace to determine the x-distance between the beginning and end of N complete periods, or cycles. Then divide the total distance by N.

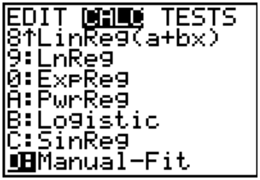
After your first attempt to use **SinReg** and the default value for *iterations* to fit the data, you may find the fit to be approximately correct, but not optimal. For an optimal fit, execute **SinReg 16,**_Xlistname_**,**_Ylistname_**,2π/**_b_ where *b* is the value obtained from the previous **SinReg** execution.

Manual Linear Fit

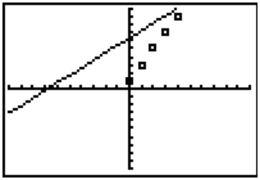
Manual Linear Fit allows you to visually fit a linear function to a scatter plot. Manual Linear Fit is an option in the STAT [CALC] menu.

After entering List data and viewing the StatPlot, select the Manual-Fit function.

1. Press STAT to display the Stat menu. Press ► to select **CALC**. Press ▼ several times to scroll down to select **D:Manual-Fit.** Press ENTER. This displays a free-floating cursor at the center of the display screen



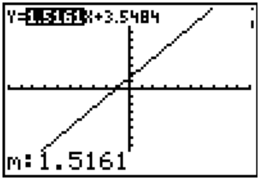
2. Press the cursor navigation keys (▲ ▼ ◀ ▶) to move the cursor to the desired location. Press ENTER to select the first point.
3. Press the cursor navigation keys (▲ ▼ ◀ ▶) to move the cursor to the second location. Press ENTER. This displays a line containing the two points selected.



The linear function is displayed. The Manual-Fit Line equation displays in the form of Y=mX+b. The current value of the first parameter (m) is highlighted in the symbolic expression.

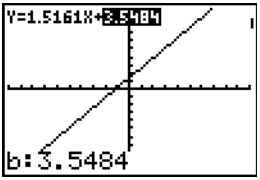
Modify parameter values

Press the cursor navigation keys (◀ ▶) to move from the first parameter (m) or (b) the second parameter. You can press ENTER and type a new parameter value. Press ENTER to display the new parameter value. When you edit the value of the selected parameter, the edit can include insert, delete, type over, or mathematical expression.



Y=1.5161X+3.5484

m:1.5161



Y=1.5161X+3.5484

b:3.5484

The screen dynamically displays the revised parameter value. Press ENTER to complete the modification of the selected parameter, save the value, and refresh the displayed graph. The system displays the revised parameter value in the symbolic expression Y=mX+B, and refreshes the graph with the updated Manual-Fit Line.

Select 2nd [QUIT] to finish the Manual Fit function. The calculator stores the current mX+b expression into Y1 and makes that function active for graphing. You can also select Manual-Fit while on the **Home** screen. You can then enter a different **Y-Var** such as **Y4** and then press ENTER. This takes you to the Graph screen and then pastes the Manual-Fit equation in the specified **Y-Var**. In this example, **Y4**.

Statistical Variables

The statistical variables are calculated and stored as indicated below. To access these variables for use in expressions, press VARS, and select **5:Statistics**. Then select the **VARS** menu shown in the column below under **VARS** menu. If you edit a list or change the type of analysis, all statistical variables are cleared.

Variables	1-Var Stats	2-Var Stats	Other	VARS menu
mean of x values	$\bar{x}$	$\bar{x}$		XY
sum of x values	Σx	Σx		Σ
sum of x^2 values	Σx^2	Σx^2		Σ
sample standard deviation of x	Sx	Sx		XY
population standard deviation of x	σx	σx		XY
number of data points	n	n		XY
mean of y values		$\bar{y}$		XY
sum of y values		Σy		Σ
sum of y^2 values		Σy^2		Σ
sample standard deviation of y		Sy		XY

Variables	**1-Var Stats**	**2-Var Stats**	**Other**	**VARS menu**
population standard deviation of y		σy		XY
sum of x ∗ y		Σxy		Σ
minimum of x values	minX	minX		XY
maximum of x values	maxX	maxX		XY
minimum of y values		minY		XY
maximum of y values		maxY		XY
1st quartile	Q1			PTS
median	Med			PTS
3rd quartile	Q3			PTS
regression/fit coefficients			a, b	EQ
polynomial, **Logistic**, and **SinReg** coefficients			a, b, c, d, e	EQ
correlation coefficient			r	EQ
coefficient of determination			r^2, R^2	EQ
regression equation			RegEQ	EQ
summary points (**Med-Med** only)			x1, y1, x2, y2, x3, y3	PTS

Q1 and Q3

The first quartile (**Q1**) is the median of points between **minX** and **Med** (median). The third quartile (**Q3**) is the median of points between **Med** and **maxX**.

Statistical Analysis in a Program

Entering Stat Data

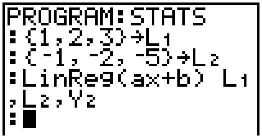
You can enter statistical data, calculate statistical results, and fit models to data from a program. You can enter statistical data into lists directly within the program (Chapter 11).

```
PROGRAM:STATS
:{1,2,3}→L₁
:{⁻1,⁻2,⁻5}→L₂
```

Statistical Calculations

To perform a statistical calculation from a program, follow these steps.

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 to use in the calculation. Separate the list names with a comma.
3. Enter a comma and then the name of a Y= variable, if you want to store the regression equation to a Y= variable.



```
PROGRAM:STATS
:{1,2,3}→L₁
:{⁻1,⁻2,⁻5}→L₂
:LinReg(ax+b) L₁
,L₂,Y₂
:
```

Statistical Plotting

Steps for Plotting Statistical Data in Lists

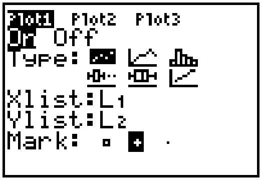
You can plot statistical data that is stored in lists. The six types of plots available are scatter plot, xyLine, histogram, modified box plot, regular box plot, and normal probability plot. You can define up to three plots.

To plot statistical data in lists, follow these steps.

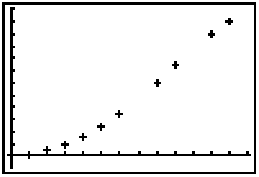
1. Store the stat data in one or more lists.
2. Select or deselect Y= functions as appropriate.
3. Define the stat plot.
4. Turn on the plots you want to display.
5. Define the viewing window.
6. Display and explore the graph.

Scatter

Scatter (⋰)plots plot the data points from **Xlist** and **Ylist** as coordinate pairs, showing each point as a box (□), cross (**+**), or dot (•). **Xlist** and **Ylist** must be the same length. You can use the same list for **Xlist** and **Ylist**.

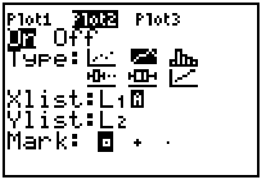


```
Plot1 Plot2 Plot3
On Off
Type:
Xlist:L1
Ylist:L2
Mark: □ + ·
```

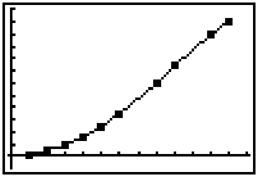


xyLine

xyLine (⟋)is a scatter plot in which the data points are plotted and connected in order of appearance in **Xlist** and **Ylist**. You may want to use **SortA(** or **SortD(** to sort the lists before you plot them.

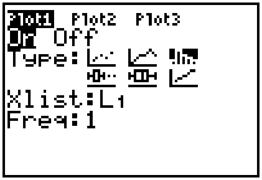


```
Plot1 Plot2 Plot3
On Off
Type:
Xlist:L1
Ylist:L2
Mark: □ + ·
```

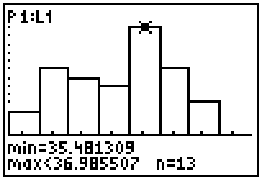


Histogram

Histogram (▟▙▖) plots one-variable data. The **Xscl** window variable value determines the width of each bar, beginning at **Xmin**. **ZoomStat** adjusts **Xmin**, **Xmax**, **Ymin**, and **Ymax** to include all values, and also adjusts **Xscl**. The inequality (**Xmax** − **Xmin**) ∕ **Xscl** ≤ 47 must be true. A value that occurs on the edge of a bar is counted in the bar to the right.



```
Plot1 Plot2 Plot3
On Off
Type:
Xlist:L1
Freq:1
```



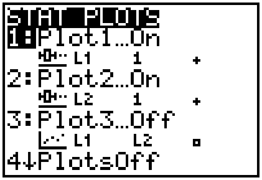
```
P1:L1
min=35.481309
max<36.985507  n=13
```

ModBoxplot

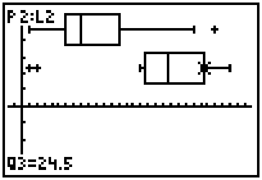
ModBoxplot (⊢□⋯) (modified box plot) plots one-variable data, like the regular box plot, except points that are 1.5 ∗ Interquartile Range beyond the quartiles. (The Interquartile Range is defined as the difference between the third quartile **Q3** and the first quartile **Q1**.) These points are plotted individually beyond the whisker, using the **Mark** (☐ or **+** or •) you select. You can trace these points, which are called outliers.

The prompt for outlier points is **x=**, except when the outlier is the maximum point (**maxX**) or the minimum point (**minX**). When outliers exist, the end of each whisker will display **x=**. When no outliers exist, **minX** and **maxX** are the prompts for the end of each whisker. **Q1**, **Med** (median), and **Q3** define the box.

Box plots are plotted with respect to **Xmin** and **Xmax**, but ignore **Ymin** and **Ymax**. When two box plots are plotted, the first one plots at the top of the screen and the second plots in the middle. When three are plotted, the first one plots at the top, the second in the middle, and the third at the bottom.



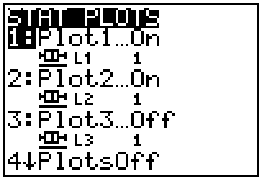
```
STAT PLOTS
1:Plot1…On
    L1    1     +
2:Plot2…On
    L2    1     +
3:Plot3…Off
    L1    L2    ▫
4↓PlotsOff
```



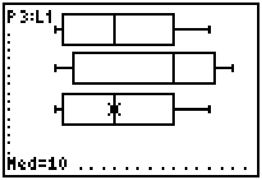
Boxplot

Boxplot ()(regular 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**, **Med** (median), and **Q3**.

Box plots are plotted with respect to **Xmin** and **Xmax**, but ignore **Ymin** and **Ymax**. When two box plots are plotted, the first one plots at the top of the screen and the second plots in the middle. When three are plotted, the first one plots at the top, the second in the middle, and the third at the bottom.



```
STAT PLOTS
1:Plot1…On
    L1    1
2:Plot2…On
    L2    1
3:Plot3…Off
    L3    1
4↓PlotsOff
```

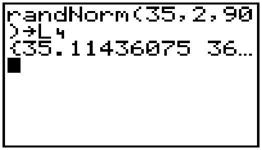


NormProbPlot

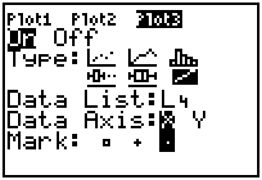
NormProbPlot (⦣) (normal probability plot) plots each observation X in **Data List** versus the corresponding quantile z of the standard normal distribution. If the plotted points lie close to a straight line, then the plot indicates that the data are normal.

Enter a valid list name in the **Data List** field. Select X or Y for the **Data Axis** setting.

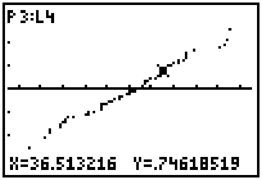
- If you select X, the TI-84 Plus plots the data on the x-axis and the z-values on the y-axis.
- If you select Y, the TI-84 Plus plots the data on the y-axis and the z-values on the x-axis.



```
randNorm(35,2,90
)→L4
{35.11436075 36…
```



```
Plot1 Plot2 Plot3
On Off
Type:
Data List:L4
Data Axis:X Y
Mark: ▫ + ·
```

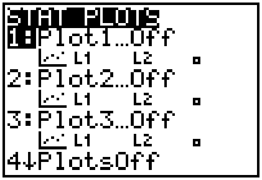


```
P3:L4
X=36.513216  Y=.74618519
```

Defining the Plots

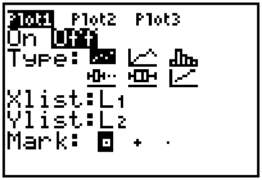
To define a plot, follow these steps.

1. Press 2nd [STAT PLOT]. The **STAT PLOTS** menu is displayed with the current plot definitions.



```
STAT PLOTS
1:Plot1…Off
  L1   L2   ▫
2:Plot2…Off
  L1   L2   ▫
3:Plot3…Off
  L1   L2   ▫
4↓PlotsOff
```

2. Select the plot you want to use. The stat plot editor is displayed for the plot you selected.



```
Plot1  Plot2  Plot3
On Off
Type:
Xlist:L1
Ylist:L2
Mark: ▫ + ·
```

3. Press ENTER to select **On** if you want to plot the statistical data immediately. The definition is stored whether you select **On** or **Off**.
4. Select the type of plot. Each type prompts for the options checked in this table.

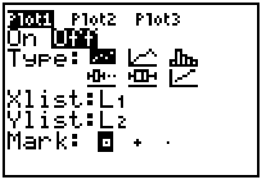
Plot Type	XList	YList	Mark	Freq	Data List	Data Axis
Scatter	☑	☑	☑	☐	☐	☐
xyLine	☑	☑	☑	☐	☐	☐
Histogram	☑	☐	☐	☑	☐	☐

Plot Type	XList	YList	Mark	Freq	Data List	Data Axis
ModBoxplot	☑	☐	☑	☑	☐	☐
Boxplot	☑	☐	☐	☑	☐	☐
NormProbPlot	☐	☐	☑	☐	☑	☑

5. Enter list names or select options for the plot type.
    - **Xlist** (list name containing independent data)
    - **Ylist** (list name containing dependent data)
    - **Mark** (☐ or **+** or •)
    - **Freq** (frequency list for **Xlist** elements; default is **1**)
    - **Data List** (list name for **NormProbPlot**)
    - **Data Axis** (axis on which to plot **Data List**)

Displaying Other Stat Plot Editors

Each stat plot has a unique stat plot editor. The name of the current stat plot (**Plot1**, **Plot2**, or **Plot3**) is highlighted in the top line of the stat plot editor. To display the stat plot editor for a different plot, press ▲ and ▶ to move the cursor onto the name in the top line, and then press ENTER. The stat plot editor for the selected plot is displayed, and the selected name remains highlighted.

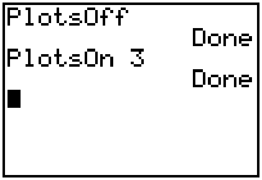


```
Plot1 Plot2 Plot3
On Off
Type:
Xlist:L1
Ylist:L2
Mark: □ + ·
```

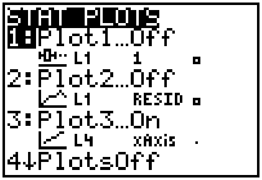
Turning On and Turning Off Stat Plots

PlotsOn and **PlotsOff** allow you to turn on or turn off stat plots from the home screen or a program. With no plot number, **PlotsOn** turns on all plots and **PlotsOff** turns off all plots. With one or more plot numbers (1, 2, and 3), **PlotsOn** turns on specified plots, and **PlotsOff** turns off specified plots.

PlotsOff [**1,2,3**]
PlotsOn [**1,2,3**]



```
PlotsOff
                Done
PlotsOn 3
                Done
```



```
STAT PLOTS
1:Plot1…Off
    L1    1     □
2:Plot2…Off
    L1    RESID □
3:Plot3…On
    L4    XAxis ·
4↓PlotsOff
```

Note: You also can turn on and turn off stat plots in the top line of the Y= editor (Chapter 3).

Defining the Viewing Window

Stat plots are displayed on the current graph. To define the viewing window, press WINDOW and enter values for the window variables. **ZoomStat** redefines the viewing window to display all statistical data points.

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 histogram, the cursor moves from the top center of one column to the top center of the next, starting at the first column.

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 press ▲ or ▼ to move to another plot or to another Y= function, tracing moves to the current or beginning point on that plot (not the nearest pixel).

The **ExprOn**/**ExprOff** format setting applies to stat plots (Chapter 3). When **ExprOn** is selected, the plot number and plotted data lists are displayed in the top-left corner.

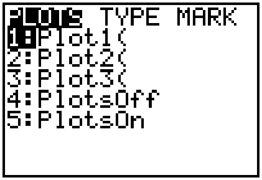
Statistical Plotting in a Program

Defining a Stat Plot in a Program

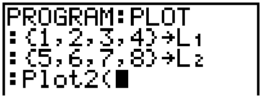
To display a stat plot from a program, define the plot, and then display the graph.

To define a stat plot from a program, begin on a blank line in the program editor and enter data into one or more lists; then, follow these steps.

1. Press 2nd [STAT PLOT] to display the **STAT PLOTS** menu.

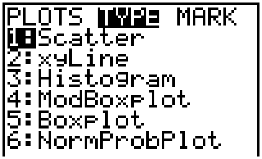


2. Select the plot to define, which pastes **Plot1(**, **Plot2(**, or **Plot3(** to the cursor location.

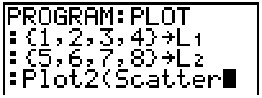


```
PROGRAM:PLOT
:{1,2,3,4}→L₁
:{5,6,7,8}→L₂
:Plot2(█
```

3. Press 2nd [STAT PLOT] ▶ to display the **STAT TYPE** menu.

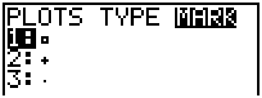


4. Select the type of plot, which pastes the name of the plot type to the cursor location.



```
PROGRAM:PLOT
:{1,2,3,4}→L₁
:{5,6,7,8}→L₂
:Plot2(Scatter█
```

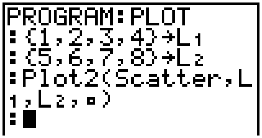
5. Press [,]. Enter the list names, separated by commas.
6. Press [,] [2nd] [STAT PLOT] [◄] to display the **STAT PLOT MARK** menu. (This step is not necessary if you selected **3:Histogram** or **5:Boxplot** in step 4.)



```
PLOTS TYPE MARK
1:□
2:+
3:·
```

Select the type of mark (□ or **+** or •) for each data point. The selected mark symbol is pasted to the cursor location.

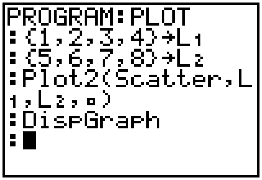
7. Press [)] [ENTER] to complete the command line.



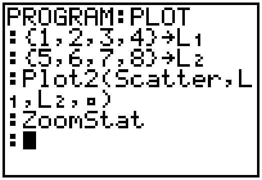
```
PROGRAM:PLOT
:{1,2,3,4}→L1
:{5,6,7,8}→L2
:Plot2(Scatter,L
1,L2,□)
:█
```

Displaying a Stat Plot from a Program

To display a plot from a program, use the **DispGraph** instruction (Chapter 16) or any of the ZOOM instructions (Chapter 3).



```
PROGRAM:PLOT
:{1,2,3,4}→L1
:{5,6,7,8}→L2
:Plot2(Scatter,L
1,L2,□)
:DispGraph
:█
```



```
PROGRAM:PLOT
:{1,2,3,4}→L1
:{5,6,7,8}→L2
:Plot2(Scatter,L
1,L2,□)
:ZoomStat
:█
```

Chapter 13: Inferential Statistics and Distributions

Getting Started: Mean Height of a Population

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

Suppose you want to estimate the mean height of a population of women given the random sample below. Because heights among a biological population tend to be normally distributed, a *t* distribution confidence interval can be used when estimating the mean. The 10 height values below are the first 10 of 90 values, randomly generated from a normally distributed population with an assumed mean of 165.1 centimeters and a standard deviation of 6.35 centimeters (**randNorm(165.1,6.35,90)** with a seed of 789).

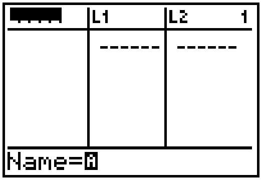
Height (in centimeters) of Each of 10 Women

169.43   168.33   159.55   169.97   159.79   181.42   171.17   162.04   167.15   159.53

1. Press STAT ENTER to display the stat list editor.

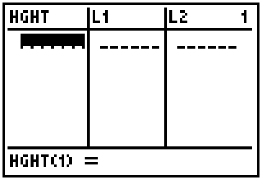
   Press ▲ to move the cursor onto **L1**, and then press 2nd [INS]. The **Name=** prompt is displayed on the bottom line. The 🅰 cursor indicates that alpha-lock is on. The existing list name columns shift to the right.

   Note: Your stat editor may not look like the one pictured here, depending on the lists you have already stored.



2. Enter **[H] [G] [H] [T]** at the **Name=** prompt, and then press [ENTER]. The list to which you will store the women's height data is created.

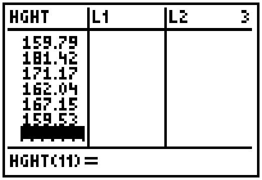
   Press [▼] to move the cursor onto the first row of the list. **HGHT(1)=** is displayed on the bottom line.



```
HGHT   |L1     |L2      1
       |------ |------
HGHT(1) =
```

3. Press **169** [.] **43** to enter the first height value. As you enter it, it is displayed on the bottom line.

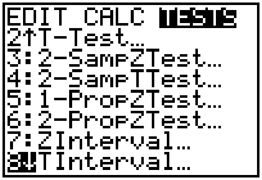
   Press [ENTER]. The value is displayed in the first row, and the rectangular cursor moves to the next row.



```
HGHT   |L1     |L2      3
159.79 |       |
181.42 |       |
171.17 |       |
162.04 |       |
167.15 |       |
159.53 |       |
HGHT(11)=
```

   Enter the other nine height values the same way.

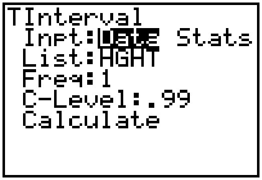
4. Press [STAT] [◀] to display the **STAT TESTS** menu, and then press [▼] until **8:TInterval** is highlighted.



5. Press [ENTER] to select **8:TInterval**. The inferential stat editor for **TInterval** is displayed. If **Data** is not selected for **Inpt:**, press [◀] [ENTER] to select **Data**.

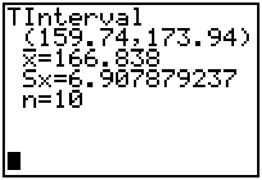
   Press [▼] and **[H] [G] [H] [T]** at the **List:** prompt (alpha-lock is on).

   Press [▼] [▼] [.] **99** to enter a 99 percent confidence level at the **C-Level:** prompt.



```
TInterval
 Inpt:Data Stats
 List:HGHT
 Freq:1
 C-Level:.99
 Calculate
```

6. Press ▼ to move the cursor onto **Calculate**, and then press ENTER. The confidence interval is calculated, and the **TInterval** results are displayed on the home screen.



```
TInterval
 (159.74,173.94)
 x̄=166.838
 Sx=6.907879237
 n=10
```

Interpret the results.

The first line, (**159.74,173.94**), shows that the 99 percent confidence interval for the population mean is between about 159.74 centimeters and 173.94 centimeters. This is about a 14.2 centimeters spread.

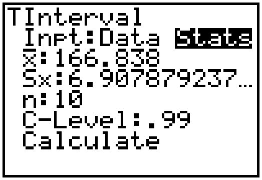
The .99 confidence level indicates that in a very large number of samples, we expect 99 percent of the intervals calculated to contain the population mean. The actual mean of the population sampled is 165.1 centimeters, which is in the calculated interval.

The second line gives the mean height of the sample x̄ used to compute this interval. The third line gives the sample standard deviation **Sx**. The bottom line gives the sample size **n**.

To obtain a more precise bound on the population mean μ of women's heights, increase the sample size to 90. Use a sample mean x̄ of 163.8 and sample standard deviation **Sx** of 7.1 calculated from the larger random sample. This time, use the **Stats** (summary statistics) input option.

7. Press STAT ◄ **8** to display the inferential stat editor for **TInterval**.

   Press ► ENTER to select **Inpt:Stats**. The editor changes so that you can enter summary statistics as input.

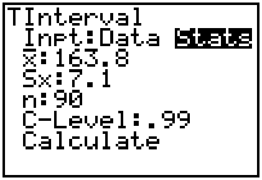


```
TInterval
 Inpt:Data Stats
 x̄:166.838
 Sx:6.907879237…
 n:10
 C-Level:.99
 Calculate
```

8. Press ▼ **163** . **8** ENTER to store 163.8 to x̄.

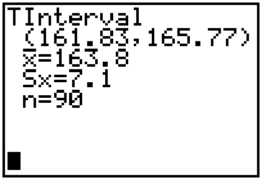
   Press **7** . **1** ENTER to store 7.1 to **Sx**.

   Press **90** ENTER to store 90 to **n**.



```
TInterval
 Inpt:Data Stats
 x̄:163.8
 Sx:7.1
 n:90
 C-Level:.99
 Calculate
```

9. Press ▼ to move the cursor onto **Calculate**, and then press ENTER to calculate the new 99 percent confidence interval. The results are displayed on the home screen.

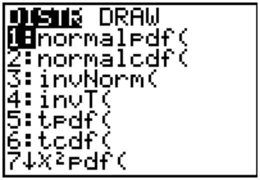


```
TInterval
 (161.83,165.77)
 x̄=163.8
 Sx=7.1
 n=90
```

If the height distribution among a population of women is normally distributed with a mean μ of 165.1 centimeters and a standard deviation σ of 6.35 centimeters, what height is exceeded by only 5 percent of the women (the 95th percentile)?

10. Press [CLEAR] to clear the home screen.

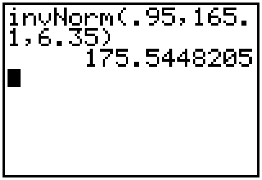
    Press [2nd] [DISTR] to display the **DISTR** (distributions) menu.



11. Press **3** to paste **invNorm(** to the home screen.

    Press [.] **95** [,] **165** [.] **1** [,] **6** [.] **35** [)] [ENTER].

    .95 is the area, 165.1 is μ, and 6.35 is σ.



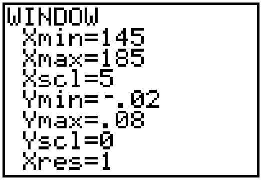
```
invNorm(.95,165.
1,6.35)
      175.5448205
```

The result is displayed on the home screen; it shows that five percent of the women are taller than 175.5 centimeters.

Now graph and shade the top 5 percent of the population.

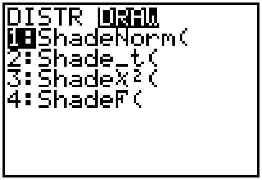
12. Press [WINDOW] and set the window variables to these values.

    Xmin=145 **Ymin=⁻.02** **Xres=1**
    Xmax=185 **Ymax=.08**
    Xscl=5 **Yscl=0**



```
WINDOW
 Xmin=145
 Xmax=185
 Xscl=5
 Ymin=⁻.02
 Ymax=.08
 Yscl=0
 Xres=1
```

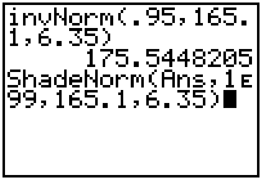
13. Press [2nd] [DISTR] [▸] to display the **DISTR DRAW** menu.



14. Press [ENTER] to paste **ShadeNorm(** to the home screen.

    Press [2nd] [ANS] [,] **1** [2nd] [EE] **99** [,] **165** [.] **1** [,] **6** [.] **35** [)].

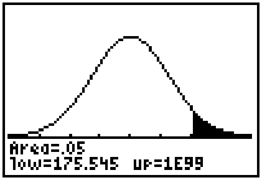
    Ans (175.5448205 from step 11) is the lower bound. 1E99 is the upper bound. The normal curve is defined by a mean μ of 165.1 and a standard deviation σ of 6.35.



```
invNorm(.95,165.
1,6.35)
         175.5448205
ShadeNorm(Ans,1E
99,165.1,6.35)
```

15. Press [ENTER] to plot and shade the normal curve.

    Area is the area above the 95th percentile. **low** is the lower bound. **up** is the upper bound.

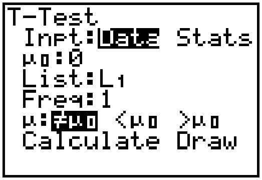


```
Area=.05
low=175.545  up=1E99
```

Inferential Stat Editors

Displaying the Inferential Stat Editors

When you select a hypothesis test or confidence interval instruction from the home screen, the appropriate inferential statistics editor is displayed. The editors vary according to each test or interval's input requirements. Below is the inferential stat editor for **T-Test**.



```
T-Test
 Inpt:Data Stats
 μ0:0
 List:L1
 Freq:1
 μ:≠μ0 <μ0 >μ0
 Calculate Draw
```

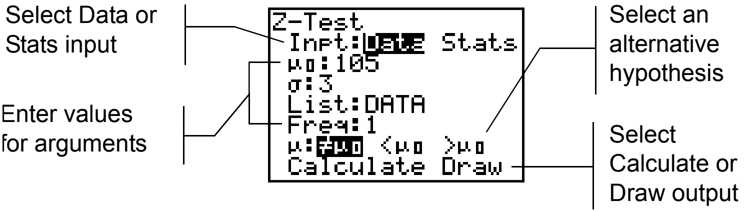
Note: When you select the **ANOVA(** instruction, it is pasted to the home screen. **ANOVA(** does not have an editor screen.

Using an Inferential Stat Editor

To use an inferential stat editor, follow these steps.

1. Select a hypothesis test or confidence interval from the **STAT TESTS** menu. The appropriate editor is displayed.
2. Select **Data** or **Stats** input, if the selection is available. The appropriate editor is displayed.
3. Enter real numbers, list names, or expressions for each argument in the editor.
4. Select the alternative hypothesis (≠ , **<**, or **>**) against which to test, if the selection is available.
5. Select **No** or **Yes** for the **Pooled** option, if the selection is available.
6. Select **Calculate** or **Draw** (when **Draw** is available) to execute the instruction.
    - When you select **Calculate**, the results are displayed on the home screen.
    - When you select **Draw**, the results are displayed in a graph.

This chapter describes the selections in the above steps for each hypothesis test and confidence interval instruction.



```
Z-Test
 Inpt:Data Stats
 μ0:105
 σ:3
 List:DATA
 Freq:1
 μ:≠μ0 <μ0 >μ0
 Calculate Draw
```

Selecting Data or Stats

Most inferential stat editors prompt you to select one of two types of input. (**1-PropZInt** and **2-PropZTest**, **1-PropZInt** and **2-PropZInt**, χ^2**-Test**, χ^2**GOF-Test**, **LinRegTInt**, and **LinRegTTest** do not.)

- Select **Data** to enter the data lists as input.
- Select **Stats** to enter summary statistics, such as $\bar{x}$, **Sx**, and **n**, as input.

To select **Data** or **Stats**, move the cursor to either **Data** or **Stats**, and then press $\boxed{\text{ENTER}}$.

Entering the Values for Arguments

Inferential stat editors require a value for every argument. If you do not know what a particular argument symbol represents, see the Inferential Statistics Input Descriptions tables.

When you enter values in any inferential stat editor, the TI-84 Plus stores them in memory so that you can run many tests or intervals without having to reenter every value.

Selecting an Alternative Hypothesis (≠ < >)

Most of the inferential stat editors for the hypothesis tests prompt you to select one of three alternative hypotheses.

- The first is a ≠ alternative hypothesis, such as μ≠μ0 for the **Z-Test**.
- The second is a **<** alternative hypothesis, such as μ1<μ2 for the **2-SampTTest**.
- The third is a **>** alternative hypothesis, such as p1>p2 for the **2-PropZTest**.

To select an alternative hypothesis, move the cursor to the appropriate alternative, and then press ENTER.

Selecting the Pooled Option

Pooled (**2-SampTTest** and **2-SampTInt** only) specifies whether the variances are to be pooled for the calculation.

- Select **No** if you do not want the variances pooled. Population variances can be unequal.
- Select **Yes** if you want the variances pooled. Population variances are assumed to be equal.

To select the **Pooled** option, move the cursor to **Yes**, and then press ENTER.

Selecting Calculate or Draw for a Hypothesis Test

After you have entered all arguments in an inferential stat editor for a hypothesis test, you must select whether you want to see the calculated results on the home screen (**Calculate**) or on the graph screen (**Draw**).

- **Calculate** calculates the test results and displays the outputs on the home screen.
- **Draw** draws a graph of the test results and displays the test statistic and p-value with the graph. The window variables are adjusted automatically to fit the graph.

To select **Calculate** or **Draw**, move the cursor to either **Calculate** or **Draw**, and then press ENTER. The instruction is immediately executed.

Selecting Calculate for a Confidence Interval

After you have entered all arguments in an inferential stat editor for a confidence interval, select **Calculate** to display the results. The **Draw** option is not available.

When you press ENTER, **Calculate** calculates the confidence interval results and displays the outputs on the home screen.

Bypassing the Inferential Stat Editors

To paste a hypothesis test or confidence interval instruction to the home screen without displaying the corresponding inferential stat editor, select the instruction you want from the **CATALOG** menu. Appendix A describes the input syntax for each hypothesis test and confidence interval instruction.

```
2-SampZTest(
```

Note: You can paste a hypothesis test or confidence interval instruction to a command line in a program. From within the program editor, select the instruction from either the **CATALOG** (Chapter 15) or the **STAT TESTS** menu.

STAT TESTS Menu

STAT TESTS Menu

To display the **STAT TESTS** menu, press STAT ◄. When you select an inferential statistics instruction, the appropriate inferential stat editor is displayed.

Most **STAT TESTS** instructions store some output variables to memory. For a list of these variables, see the Test and Interval Output Variables table.

`EDIT CALC TESTS`	
`1: Z-Test...`	Test for 1 μ, known σ
`2: T-Test...`	Test for 1 μ, unknown σ
`3: 2-SampZTest...`	Test comparing 2 μ's, known σ's
`4: 2-SampTTest...`	Test comparing 2 μ's, unknown σ's
`5: 1-PropZTest...`	Test for 1 proportion
`6: 2-PropZTest...`	Test comparing 2 proportions
`7: ZInterval...`	Confidence interval for 1 μ, known σ
`8: TInterval...`	Confidence interval for 1 μ, unknown σ
`9: 2-SampZInt...`	Confidence interval for difference of 2 μ's, known σ's

EDIT CALC TESTS	
0: 2-SampTInt...	Confidence interval for difference of 2 μ's, unknown σ's
A: 1-PropZInt...	Confidence interval for 1 proportion
B: 2-PropZInt...	Confidence interval for difference of 2 proportions
C: χ^2-Test...	Chi-square test for 2-way tables
D: χ^2-GOF Test...	Chi-square Goodness of Fit test
E: 2-SampFTest...	Test comparing 2 σ's
F: LinRegTTest...	*t* test for regression slope and ρ
G: LinRegTInt...	Confidence interval for linear regression slope coefficient b
H: ANOVA(	One-way analysis of variance

Note: When a new test or interval is computed, all previous output variables are invalidated.

Inferential Stat Editors for the STAT TESTS Instructions

In this chapter, the description of each **STAT TESTS** instruction shows the unique inferential stat editor for that instruction with example arguments.

- Descriptions of instructions that offer the **Data/Stats** input choice show both types of input screens.
- Descriptions of instructions that do not offer the **Data/Stats** input choice show only one input screen.

The description then shows the unique output screen for that instruction with the example results.

- Descriptions of instructions that offer the **Calculate/Draw** output choice show both types of screens: calculated and graphic results.
- Descriptions of instructions that offer only the **Calculate** output choice show the calculated results on the home screen.

Z-Test

Z-Test (one-sample z test; item **1**) performs a hypothesis test for a single unknown population mean μ when the population standard deviation σ is known. It tests the null hypothesis H_0: $\mu=\mu_0$ against one of the alternatives below.

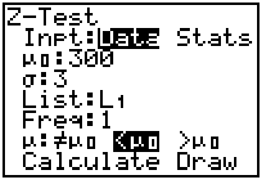
- H_a: $\mu\neq\mu_0$ (μ**:**$\neq\mu$**0**)
- H_a: $\mu<\mu_0$ (μ**:<**μ**0**)
- H_a: $\mu>\mu_0$ (μ**:>**μ**0**)

In the example:

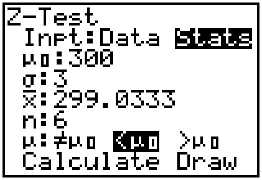
L1={299.4 297.7 301 298.9 300.2 297}

Data **Stats**

Input:

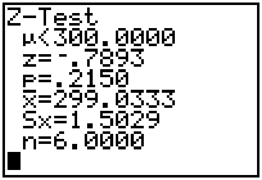


```
Z-Test
 Inpt:Data Stats
 μ0:300
 σ:3
 List:L1
 Freq:1
 μ:≠μ0 <μ0 >μ0
 Calculate Draw
```

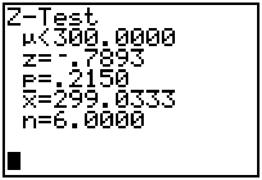


```
Z-Test
 Inpt:Data Stats
 μ0:300
 σ:3
 x̄:299.0333
 n:6
 μ:≠μ0 <μ0 >μ0
 Calculate Draw
```

Calculated results:

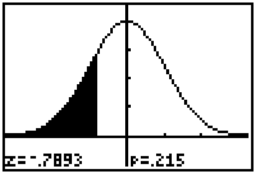


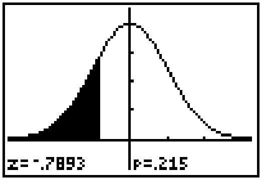
```
Z-Test
 μ<300.0000
 z=⁻.7893
 p=.2150
 x̄=299.0333
 Sx=1.5029
 n=6.0000
```



```
Z-Test
 μ<300.0000
 z=⁻.7893
 p=.2150
 x̄=299.0333
 n=6.0000
```

Drawn results:





Note: All **STAT TESTS** examples assume a fixed-decimal mode setting of 4 (Chapter 1). If you set the decimal mode to **Float** or a different fixed-decimal setting, your output may differ from the output in the examples.

T-Test

T-Test (one-sample *t* test; item **2**) performs a hypothesis test for a single unknown population mean μ when the population standard deviation σ is unknown. It tests the null hypothesis H_0: $\mu=\mu_0$ against one of the alternatives below.

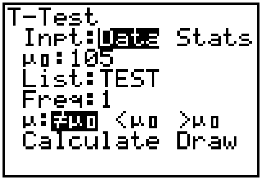
- H_a: $\mu\neq\mu_0$ (μ:≠μ**0**)
- H_a: $\mu<\mu_0$ (μ:<μ**0**)
- H_a: $\mu>\mu_0$ (μ:>μ**0**)

In the example:

TEST={91.9 97.8 111.4 122.3 105.4 95}

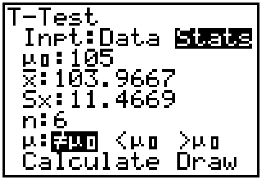
Data

Input:



```
T-Test
 Inpt:Data Stats
 μ0:105
 List:TEST
 Freq:1
 μ:≠μ0 <μ0 >μ0
 Calculate Draw
```

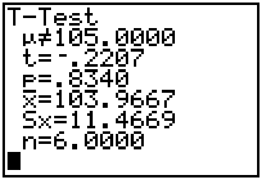
Stats



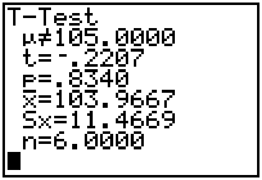
```
T-Test
 Inpt:Data Stats
 μ0:105
 x̄:103.9667
 Sx:11.4669
 n:6
 μ:≠μ0 <μ0 >μ0
 Calculate Draw
```

Data **Stats**

Calculated results:

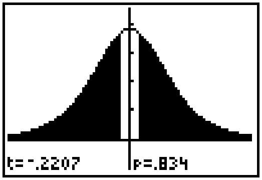


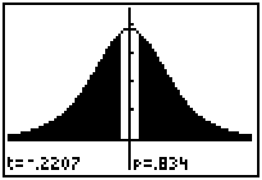
```
T-Test
 μ≠105.0000
 t=⁻.2207
 p=.8340
 x̄=103.9667
 Sx=11.4669
 n=6.0000
```



```
T-Test
 μ≠105.0000
 t=⁻.2207
 p=.8340
 x̄=103.9667
 Sx=11.4669
 n=6.0000
```

Drawn results:





2-SampZTest

2-SampZTest (two-sample z test; item **3)**) tests the equality of the means of two populations (μ_1 and μ_2) based on independent samples when both population standard deviations (σ_1 and σ_2) are known. The null hypothesis H_0: $\mu_1=\mu_2$ is tested against one of the alternatives below.

- H_a: $\mu_1\neq\mu_2$ (μ**1:**≠μ**2**)
- H_a: $\mu_1<\mu_2$ (μ**1:<**μ**2**)
- H_a: $\mu_1>\mu_2$ (μ**1:>**μ**2**)

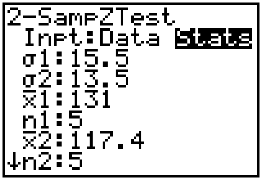
In the example:

LISTA={154 109 137 115 140}
LISTB={108 115 126 92 146}

Data / **Stats**

Input:

```
2-SampZTest
 Inpt:Data Stats
 σ1:15.5
 σ2:13.5
 List1:LISTA
 List2:LISTB
 Freq1:1
↓Freq2:1
```

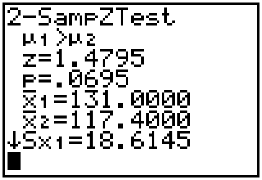


```
2-SampZTest
 Inpt:Data Stats
 σ1:15.5
 σ2:13.5
 x̄1:131
 n1:5
 x̄2:117.4
↓n2:5
```

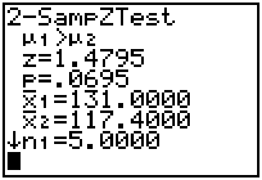
```
 μ1:≠μ2 <μ2 >μ2
 Calculate Draw
```

```
 μ1:≠μ2 <μ2 >μ2
 Calculate Draw
```

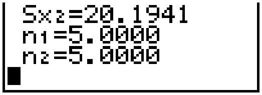
Calculated results:



```
2-SampZTest
 μ1>μ2
 z=1.4795
 p=.0695
 x̄1=131.0000
 x̄2=117.4000
↓Sx1=18.6145
```

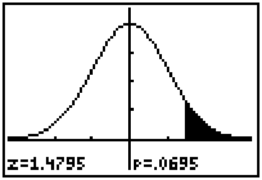
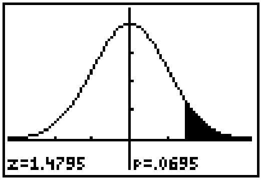


```
2-SampZTest
 μ1>μ2
 z=1.4795
 p=.0695
 x̄1=131.0000
 x̄2=117.4000
↓n1=5.0000
```



```
 Sx2=20.1941
 n1=5.0000
 n2=5.0000
```

```
 n2=5.0000
```

	Data	**Stats**
Drawn results:	 z=1.4795 p=.0695	 z=1.4795 p=.0695

2-SampTTest

2-SampTTest (two-sample t test; item **4**) tests the equality of the means of two populations (μ_1 and μ_2) based on independent samples when neither population standard deviation (σ_1 or σ_2) is known. The null hypothesis H_0: $\mu_1=\mu_2$ is tested against one of the alternatives below.

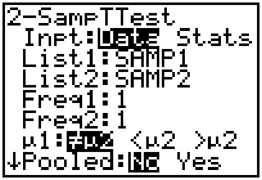
- H_a: $\mu_1\neq\mu_2$ (μ**1:**$\neq\mu$**2**)
- H_a: $\mu_1<\mu_2$ (μ**1:<**μ**2**)
- H_a: $\mu_1>\mu_2$ (μ**1:>**μ**2**)

In the example:

SAMP1={12.207 16.869 25.05 22.429 8.456 10.589}
SAMP2={11.074 9.686 12.064 9.351 8.182 6.642}

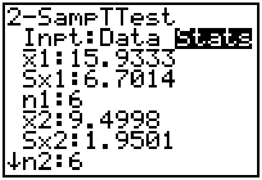
Data **Stats**

Input:

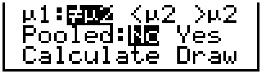


```
2-SampTTest
 Inpt:Data Stats
 List1:SAMP1
 List2:SAMP2
 Freq1:1
 Freq2:1
 μ1:≠μ2 <μ2 >μ2
↓Pooled:No Yes
```

```
 Calculate Draw
```

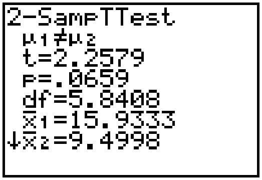


```
2-SampTTest
 Inpt:Data Stats
 x̄1:15.9333
 Sx1:6.7014
 n1:6
 x̄2:9.4998
 Sx2:1.9501
↓n2:6
```

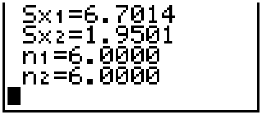


```
 μ1:≠μ2 <μ2 >μ2
 Pooled:No Yes
 Calculate Draw
```

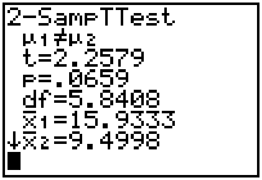
Calculated results:



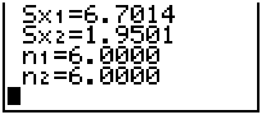
```
2-SampTTest
 μ1≠μ2
 t=2.2579
 p=.0659
 df=5.8408
 x̄1=15.9333
↓x̄2=9.4998
```



```
 Sx1=6.7014
 Sx2=1.9501
 n1=6.0000
 n2=6.0000
```



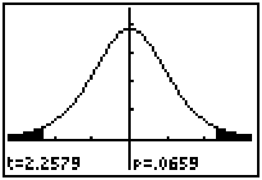
```
2-SampTTest
 μ1≠μ2
 t=2.2579
 p=.0659
 df=5.8408
 x̄1=15.9333
↓x̄2=9.4998
```

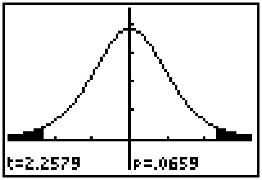


```
 Sx1=6.7014
 Sx2=1.9501
 n1=6.0000
 n2=6.0000
```

Data **Stats**

Drawn results:



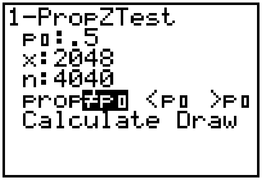


1-PropZTest

1-PropZTest (one-proportion *z* test; item **5**) computes a test for an unknown proportion of successes (prop). It takes as input the count of successes in the sample *x* and the count of observations in the sample *n*. **1-PropZTest** tests the null hypothesis H_0: prop=p_0 against one of the alternatives below.

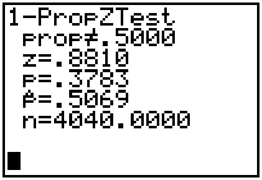
- H_a: prop≠p_0 (**prop:≠p0**)
- H_a: prop<p_0 (**prop:<p0**)
- H_a: prop>p_0 (**prop:>p0**)

Input:



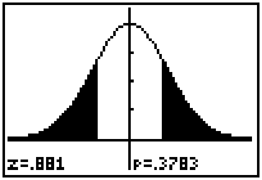
```
1-PropZTest
 p0:.5
 x:2048
 n:4040
 prop≠p0 <p0 >p0
 Calculate Draw
```

Calculated results:



```
1-PropZTest
 prop≠.5000
 z=.8810
 p=.3783
 p̂=.5069
 n=4040.0000
```

Drawn results:



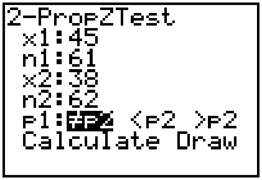
2-PropZTest

2-PropZTest (two-proportion z test; item **6**) computes a test to compare the proportion of successes (p_1 and p_2) from two populations. It takes as input the count of successes in each sample (x_1 and x_2) and the count of observations in each sample (n_1 and n_2). **2-PropZTest** tests the null hypothesis H_0: $p_1=p_2$ (using the pooled sample proportion $\hat{p}$) against one of the alternatives below.

- H_a: $p_1 \neq p_2$ (**p1:≠p2**)
- H_a: $p_1 < p_2$ (**p1:<p2**)

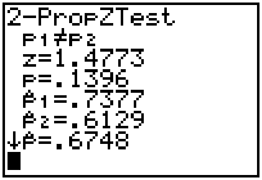
- H_a: $p_1 > p_2$ (**p1:>p2**)

Input:

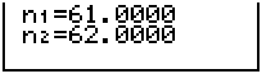


```
2-PropZTest
 x1:45
 n1:61
 x2:38
 n2:62
 p1:≠p2 <p2 >p2
 Calculate Draw
```

Calculated results:

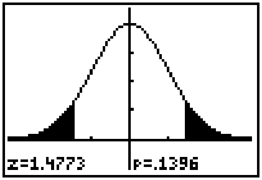


```
2-PropZTest
 p1≠p2
 z=1.4773
 p=.1396
 p̂1=.7377
 p̂2=.6129
↓p̂=.6748
```



```
 n1=61.0000
 n2=62.0000
```

Drawn results:



```
z=1.4773     p=.1396
```

ZInterval

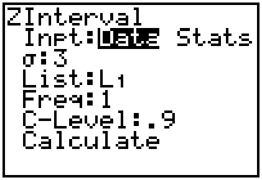
ZInterval (one-sample *z* confidence interval; item **7**) computes a confidence interval for an unknown population mean μ when the population standard deviation σ is known. The computed confidence interval depends on the user-specified confidence level.

In the example:

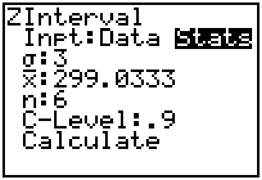
L1={299.4 297.7 301 298.9 300.2 297}

Data **Stats**

Input:

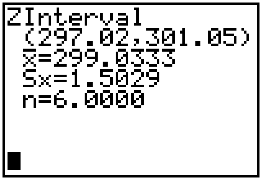


```
ZInterval
 Inpt:Data Stats
 σ:3
 List:L1
 Freq:1
 C-Level:.9
 Calculate
```

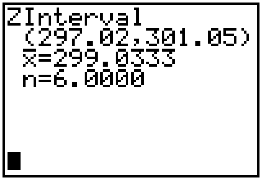


```
ZInterval
 Inpt:Data Stats
 σ:3
 x̄:299.0333
 n:6
 C-Level:.9
 Calculate
```

Calculated results:



```
ZInterval
 (297.02,301.05)
 x̄=299.0333
 Sx=1.5029
 n=6.0000
```



```
ZInterval
 (297.02,301.05)
 x̄=299.0333
 n=6.0000
```

TInterval

TInterval (one-sample *t* confidence interval; item **8**) computes a confidence interval for an unknown population mean μ when the population standard deviation σ is unknown. The computed confidence interval depends on the user-specified confidence level.

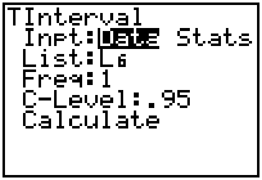
In the example:

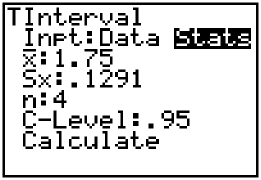
L6={1.6 1.7 1.8 1.9}

Data

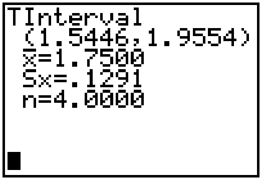
Stats

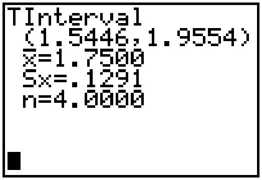
Input:


```
TInterval
 Inpt:Data Stats
 List:L6
 Freq:1
 C-Level:.95
 Calculate
```


```
TInterval
 Inpt:Data Stats
 x̄:1.75
 Sx:.1291
 n:4
 C-Level:.95
 Calculate
```

Calculated results:


```
TInterval
 (1.5446,1.9554)
 x̄=1.7500
 Sx=.1291
 n=4.0000
```


```
TInterval
 (1.5446,1.9554)
 x̄=1.7500
 Sx=.1291
 n=4.0000
```

2-SampZInt

2-SampZInt (two-sample z confidence interval; item **9**) computes a confidence interval for the difference between two population means ($\mu_1 - \mu_2$) when both population standard deviations (σ_1 and σ_2) are known. The computed confidence interval depends on the user-specified confidence level.

In the example:

LISTC={154 109 137 115 140}
LISTD={108 115 126 92 146}

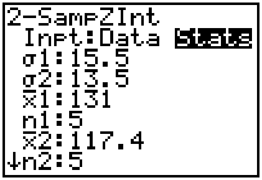
Data

Input:

```
2-SampZInt
 Inpt:Data Stats
 σ1:15.5
 σ2:13.5
 List1:LISTC
 List2:LISTD
 Freq1:1
↓Freq2:1
```

```
 C-Level:.99
 Calculate
```

Stats

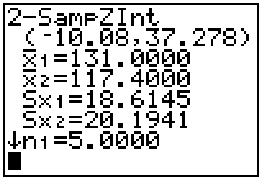


```
2-SampZInt
 Inpt:Data Stats
 σ1:15.5
 σ2:13.5
 x̄1:131
 n1:5
 x̄2:117.4
↓n2:5
```

```
 C-Level:.99
 Calculate
```

Calculated results:

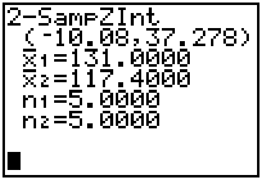
Data



```
2-SampZInt
 (⁻10.08,37.278)
 x̄1=131.0000
 x̄2=117.4000
 Sx1=18.6145
 Sx2=20.1941
↓n1=5.0000
```

```
 n2=5.0000
```

Stats



```
2-SampZInt
 (⁻10.08,37.278)
 x̄1=131.0000
 x̄2=117.4000
 n1=5.0000
 n2=5.0000
```

2-SampTInt

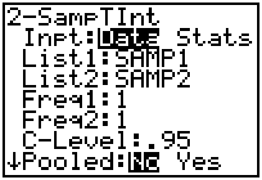
2-SampTInt (two-sample *t* confidence interval; item **0**) computes a confidence interval for the difference between two population means ($\mu_1-\mu_2$) when both population standard deviations (σ_1 and σ_2) are unknown. The computed confidence interval depends on the user-specified confidence level.

In the example:

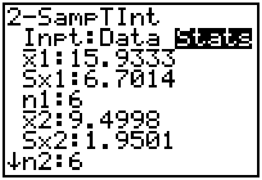
SAMP1={12.207 16.869 25.05   22.429 8.456 10.589}
SAMP2={11.074 9.686 12.064 9.351 8.182 6.642}

Data | **Stats**

Input:

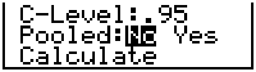


```
2-SampTInt
 Inpt:Data Stats
 List1:SAMP1
 List2:SAMP2
 Freq1:1
 Freq2:1
 C-Level:.95
↓Pooled:No Yes
```



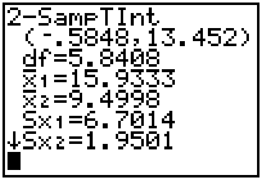
```
2-SampTInt
 Inpt:Data Stats
 x̄1:15.9333
 Sx1:6.7014
 n1:6
 x̄2:9.4998
 Sx2:1.9501
↓n2:6
```

```
 Calculate
```

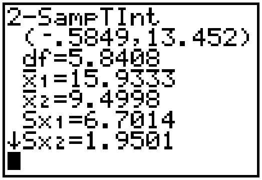


```
 C-Level:.95
 Pooled:No Yes
 Calculate
```

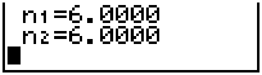
Calculated results:



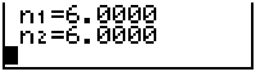
```
2-SampTInt
 (-.5848,13.452)
 df=5.8408
 x̄1=15.9333
 x̄2=9.4998
 Sx1=6.7014
↓Sx2=1.9501
```



```
2-SampTInt
 (-.5849,13.452)
 df=5.8408
 x̄1=15.9333
 x̄2=9.4998
 Sx1=6.7014
↓Sx2=1.9501
```



```
 n1=6.0000
 n2=6.0000
```

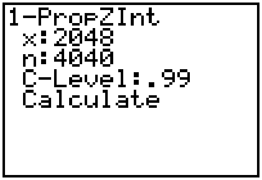


```
 n1=6.0000
 n2=6.0000
```

1-PropZInt

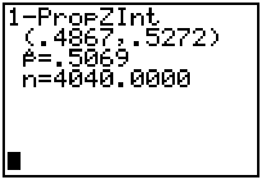
1-PropZInt (one-proportion z confidence interval; item **A**) computes a confidence interval for an unknown proportion of successes. It takes as input the count of successes in the sample x and the count of observations in the sample n. The computed confidence interval depends on the user-specified confidence level.

Input:



```
1-PropZInt
 x:2048
 n:4040
 C-Level:.99
 Calculate
```

Calculated results:

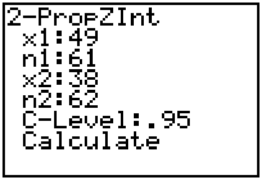


```
1-PropZInt
 (.4867,.5272)
 p̂=.5069
 n=4040.0000
```

2-PropZInt

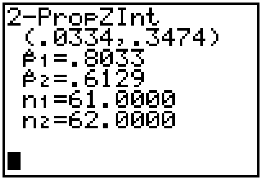
2-PropZInt (two-proportion z confidence interval; item **B**) computes a confidence interval for the difference between the proportion of successes in two populations ($p_1 - p_2$). It takes as input the count of successes in each sample (x_1 and x_2) and the count of observations in each sample (n_1 and n_2). The computed confidence interval depends on the user-specified confidence level.

Input:



```
2-PropZInt
 x1:49
 n1:61
 x2:38
 n2:62
 C-Level:.95
 Calculate
```

Calculated results:



```
2-PropZInt
 (.0334,.3474)
 p̂1=.8033
 p̂2=.6129
 n1=61.0000
 n2=62.0000
```

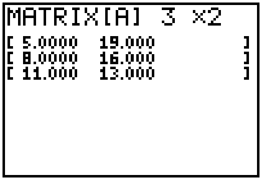
χ^2-Test

χ^2**-Test** (chi-square test; item **C**) computes a chi-square test for association on the two-way table of counts in the specified *Observed* matrix. The null hypothesis H_0 for a two-way table is: no association exists between row variables and column variables. The alternative hypothesis is: the variables are related.

Before computing a χ^2-Test, enter the observed counts in a matrix. Enter that matrix variable name at the **Observed:** prompt in the χ^2-Test editor; default=**[A]**. At the

Expected: prompt, enter the matrix variable name to which you want the computed expected counts to be stored; default=**[B]**.

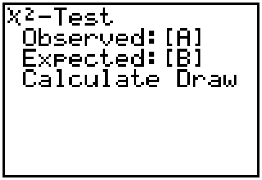
Matrix editor:



```
MATRIX[A] 3 ×2
[ 5.0000  19.000        ]
[ 8.0000  16.000        ]
[ 11.000  13.000        ]
```

Note: Press [2nd] [MATRX] [▶] [▶] **1** to select **1:[A]** from the **MATRX EDIT** menu.

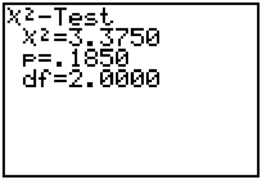
Input:



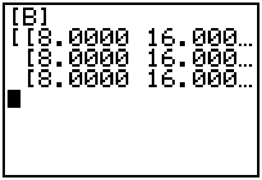
```
χ²-Test
 Observed:[A]
 Expected:[B]
 Calculate Draw
```

Note: Press [2nd] [MATRX] [▼] [ENTER] to display matrix **[B]**.

Calculated results:

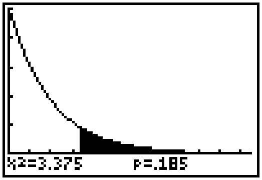


```
χ²-Test
 χ²=3.3750
 p=.1850
 df=2.0000
```



```
[B]
[[8.0000 16.000…
 [8.0000 16.000…
 [8.0000 16.000…
```

Drawn results:

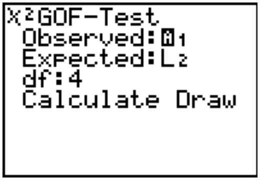


χ^2GOF-Test

χ^2GOF-**Test** (Chi Square Goodness of Fit; item D) performs a test to confirm that sample data is from a population that conforms to a specified distribution. For example, χ^2 GOF can confirm that the sample data came from a normal distribution.

In the example:
list 1={16,25,22,8,10}
list 2={16.2,21.6,16.2,14.4,12.6}

The Chi-square Goodness of Fit input screen:

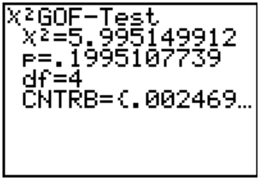


```
χ²GOF-Test
 Observed:L1
 Expected:L2
 df:4
 Calculate Draw
```

Note: Press STAT ▶ ▶ to select **TESTS**. Press ▼ several times to select **D:X^{2}GOF-Test...** Press ENTER. To enter data for df (degree of freedom), press ▼ ▼ ▼. Type 4.

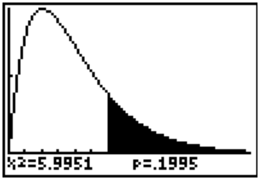
↓

Calculated results:



```
χ²GOF-Test
 χ²=5.995149912
 p=.1995107739
 df=4
 CNTRB={.002469…
```

Drawn results:



2-SampFTest

2-SampFTest (two-sample **F**-test; item **E**) computes an **F**-test to compare two normal population standard deviations (σ_1 and σ_2). The population means and standard deviations are all unknown. **2-SampFTest**, which uses the ratio of sample variances $Sx1^2/Sx2^2$, tests the null hypothesis H_0: $\sigma_1=\sigma_2$ against one of the alternatives below.

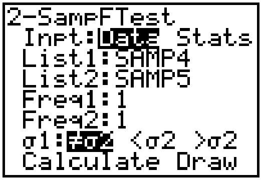
- H_a: $\sigma_1\neq\sigma_2$ (**σ1:≠σ2**)
- H_a: $\sigma_1<\sigma_2$ (**σ1:<σ2**)
- H_a: $\sigma_1>\sigma_2$ (**σ1:>σ2**)

In the example:

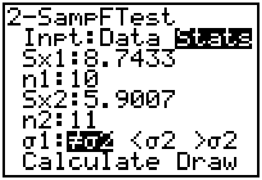
SAMP4={ 7 -4 18 17 -3 -5 1 10 11 -2}
SAMP5={ -1 12 -1 -3 3 -5 5 2 -11 -1 -3}

Data **Stats**

Input:

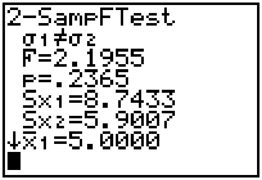


```
2-SampFTest
 Inpt:Data Stats
 List1:SAMP4
 List2:SAMP5
 Freq1:1
 Freq2:1
 σ1:≠σ2 <σ2 >σ2
 Calculate Draw
```

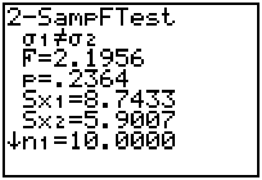


```
2-SampFTest
 Inpt:Data Stats
 Sx1:8.7433
 n1:10
 Sx2:5.9007
 n2:11
 σ1:≠σ2 <σ2 >σ2
 Calculate Draw
```

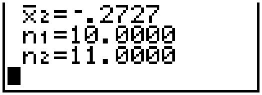
Calculated results:



```
2-SampFTest
 σ1≠σ2
 F=2.1955
 p=.2365
 Sx1=8.7433
 Sx2=5.9007
↓x̄1=5.0000
```



```
2-SampFTest
 σ1≠σ2
 F=2.1956
 p=.2364
 Sx1=8.7433
 Sx2=5.9007
↓n1=10.0000
```

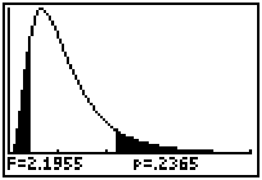


```
 x̄2=-.2727
 n1=10.0000
 n2=11.0000
```

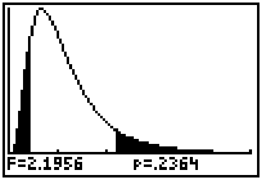
```
 n2=11.0000
```

Data

Drawn results:


F=2.1955 p=.2365

Stats


F=2.1956 p=.2364

LinRegTTest

LinRegTTest (linear regression t test; item **F)** computes a linear regression on the given data and a t test on the value of slope β and the correlation coefficient ρ for the equation y=α+βx. It tests the null hypothesis H_0: β=0 (equivalently, ρ=0) against one of the alternatives below.

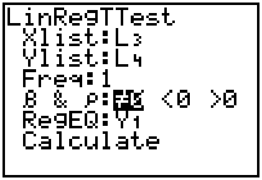
- H_a: β≠0 and ρ≠0 (β **&** ρ**: ≠0**)
- H_a: β<0 and ρ<0 (β **&** ρ**:<0**)
- H_a: β>0 and ρ>0 (β **&** ρ**:>0**)

The regression equation is automatically stored to **RegEQ** (**VARS Statistics EQ** secondary menu). If you enter a Y= variable name at the **RegEQ:** prompt, the calculated regression equation is automatically stored to the specified Y= equation. In the example below, the regression equation is stored to **Y1**, which is then selected (turned on).

In the example:

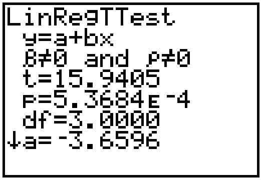
L3={ 38 56 59 64 74}
L4={ 41 63 70 72 84}

Input:

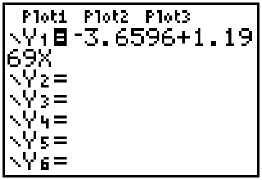


```
LinRegTTest
 Xlist:L₃
 Ylist:L₄
 Freq:1
 β & ρ:≠0 <0 >0
 RegEQ:Y₁
 Calculate
```

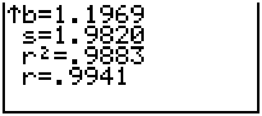
Calculated results:



```
LinRegTTest
 y=a+bx
 β≠0 and ρ≠0
 t=15.9405
 p=5.3684ᴇ⁻4
 df=3.0000
↓a=⁻3.6596
```



```
 Plot1 Plot2 Plot3
\Y₁=⁻3.6596+1.19
69X
\Y₂=
\Y₃=
\Y₄=
\Y₅=
\Y₆=
```



```
↑b=1.1969
 s=1.9820
 r²=.9883
 r=.9941
```

When **LinRegTTest** is executed, the list of residuals is created and stored to the list name **RESID** automatically. **RESID** is placed on the **LIST NAMES** menu.

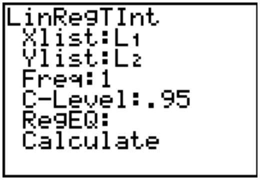
Note: For the regression equation, you can use the fix-decimal mode setting to control the number of digits stored after the decimal point (Chapter 1). However, limiting the number of digits to a small number could affect the accuracy of the fit.

LinRegTInt

LinRegTInt computes a linear regression T confidence interval for the slope coefficient b. If the confidence interval contains 0, this is insufficient evidence to indicate that the data exhibits a linear relationship.

In the example:
list 1={4, 5, 6, 7, 8}
list 2={1, 2, 3, 3.5, 4.5}

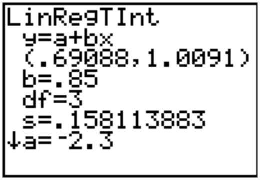
LinRegTInt input screen:



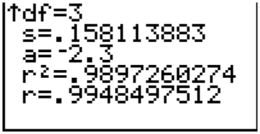
```
LinRegTInt
 Xlist:L₁
 Ylist:L₂
 Freq:1
 C-Level:.95
 RegEQ:
 Calculate
```

Note: Press STAT ▸ ▸ to select **TESTS**. Press ▾ several times to select **G:LinRegTint...** Press ENTER. Press ▾ several times to select **Calculate**. Press ENTER.

Calculated results:



```
LinRegTInt
 y=a+bx
 (.69088,1.0091)
 b=.85
 df=3
 s=.158113883
↓a=⁻2.3
```



```
↑df=3
 s=.158113883
 a=⁻2.3
 r²=.9897260274
 r=.9948497512
```

Xlist, Ylist is the list of independent and dependent variables. The list containing the **Freq** (frequency) values for the data is stored in **List**. The default is 1. All elements must be real numbers. Each element in the **Freq** list is the frequency of occurence for each corresponding data point in the input list specified in the **List** fields. RegEQ (optional) is the designated Yn variable for storing the regression equation. StoreRegEqn (optional) is the designated variable for storing the regression equation. The C level is the Confidence level probability with default = .95.

ANOVA(

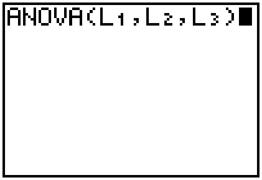
ANOVA((one-way analysis of variance; item **H**) computes a one-way analysis of variance for comparing the means of two to 20 populations. The **ANOVA** procedure for comparing these means involves analysis of the variation in the sample data. The null hypothesis H_0: $\mu_1=\mu_2=\ldots=\mu_k$ is tested against the alternative H_a: not all $\mu_1\ldots\mu_k$ are equal.

ANOVA(_list1_**,**_list2_**[,**_…_**,**_list20_**])**

In the example:

L1={7 4 6 6 5}
L2={6 5 5 8 7}
L3={4 7 6 7 6}

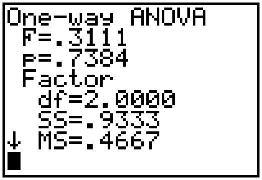
Input:



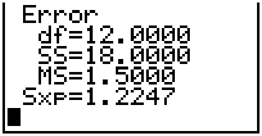
```
ANOVA(L₁,L₂,L₃)
```

↓

Calculated results:



```
One-way ANOVA
 F=.3111
 p=.7384
 Factor
  df=2.0000
  SS=.9333
↓ MS=.4667
```



```
 Error
  df=12.0000
  SS=18.0000
  MS=1.5000
 Sxp=1.2247
```

Note: SS is sum of squares and **MS** is mean square.

Inferential Statistics Input Descriptions

The tables in this section describe the inferential statistics inputs discussed in this chapter. You enter values for these inputs in the inferential stat editors. The tables present the inputs in the same order that they appear in this chapter.

Input	Description
μ_0	Hypothesized value of the population mean that you are testing.
σ	The known population standard deviation; must be a real number > 0.

Input	Description
List	The name of the list containing the data you are testing.
Freq	The name of the list containing the frequency values for the data in **List**. Default=1. All elements must be integers ≥ 0.
Calculate/**Draw**	Determines the type of output to generate for tests and intervals. **Calculate** displays the output on the home screen. In tests, **Draw** draws a graph of the results.
$\bar{x}$, **Sx**, **n**	Summary statistics (mean, standard deviation, and sample size) for the one-sample tests and intervals.
σ**1**	The known population standard deviation from the first population for the two-sample tests and intervals. Must be a real number > 0.
σ**2**	The known population standard deviation from the second population for the two-sample tests and intervals. Must be a real number > 0.
List1, **List2**	The names of the lists containing the data you are testing for the two-sample tests and intervals. Defaults are **L1** and **L2**, respectively.
Freq1, **Freq2**	The names of the lists containing the frequencies for the data in **List1** and **List2** for the two-sample tests and intervals. Defaults=1. All elements must be integers ≥ 0.
$\bar{x}$**1**, **Sx1**, *n***1**, $\bar{x}$**2**, **Sx2**, *n***2**	Summary statistics (mean, standard deviation, and sample size) for sample one and sample two in the two-sample tests and intervals.
Pooled	Specifies whether variances are to be pooled for **2-SampTTest** and **2-SampTInt**. **No** instructs the TI-84 Plus not to pool the variances. **Yes** instructs the TI-84 Plus to pool the variances.

Input	Description
p_0	The expected sample proportion for **1-PropZTest**. Must be a real number, such that $0 < p_0 < 1$.
x	The count of successes in the sample for the **1-PropZTest** and **1-PropZInt.** Must be an integer ≥ 0.
n	The count of observations in the sample for the **1-PropZTest** and **1-PropZInt**. Must be an integer > 0.
x1	The count of successes from sample one for the **2-PropZTest** and **2-PropZInt**. Must be an integer ≥ 0.
x2	The count of successes from sample two for the **2-PropZTest** and **2-PropZInt**. Must be an integer ≥ 0.
n1	The count of observations in sample one for the **2-PropZTest** and **2-PropZInt**. Must be an integer > 0.
n2	The count of observations in sample two for the **2-PropZTest** and **2-PropZInt**. Must be an integer > 0.
C-Level	The confidence level for the interval instructions. Must be ≥ 0 and < 100. If it is ≥ 1, it is assumed to be given as a percent and is divided by 100. Default=0.95.
Observed (Matrix)	The matrix name that represents the columns and rows for the observed values of a two-way table of counts for the χ^2**-Test** and χ^2**GOF-Test**. **Observed** must contain all integers ≥ 0. Matrix dimensions must be at least 2×2.
Expected (Matrix)	The matrix name that specifies where the expected values should be stored. **Expected** is created upon successful completion of the χ^2**-Test** and χ^2**GOF-Test**.

Input	Description
df	df (degree of freedom) represents (number of sample categories) - (number of estimated parameters for the selected distribution + 1).
Xlist, **Ylist**	The names of the lists containing the data for **LinRegTTest** and **LinRegTInt**. Defaults are **L1** and **L2**, respectively. The dimensions of **Xlist** and **Ylist** must be the same.
RegEQ	The prompt for the name of the Y= variable where the calculated regression equation is to be stored. If a Y= variable is specified, that equation is automatically selected (turned on). The default is to store the regression equation to the **RegEQ** variable only.

Test and Interval Output Variables

The inferential statistics variables are calculated as indicated below. To access these variables for use in expressions, press VARS **5** (**5:Statistics**), and then select the **VARS** menu listed in the last column below.

Variables	Tests	Intervals	LinRegTTest, ANOVA	VARS Menu
p-value	**p**		**p**	TEST
test statistics	**z, t**, χ^2, **F**		**t, F**	TEST
degrees of freedom	**df**	**df**	**df**	TEST
sample mean of x values for sample 1 and sample 2	$\bar{x}$**1**, $\bar{x}$**2**	$\bar{x}$**1**, $\bar{x}$**2**		TEST
sample standard deviation of x for sample 1 and sample 2	**Sx1, Sx2**	**Sx1, Sx2**		TEST

Variables	**Tests**	**Intervals**	**LinRegTTest, ANOVA**	**VARS Menu**
number of data points for sample 1 and sample 2	**n1, n2**	**n1, n2**		TEST
pooled standard deviation	**SxP**	**SxP**	**SxP**	TEST
estimated sample proportion	$\hat{p}$	$\hat{p}$		TEST
estimated sample proportion for population 1	$\hat{p}$**1**	$\hat{p}$**1**		TEST
estimated sample proportion for population 2	$\hat{p}$**2**	$\hat{p}$**2**		TEST
confidence interval pair		**lower, upper**		TEST
mean of x values	$\bar{x}$	$\bar{x}$		XY
sample standard deviation of x	**Sx**	**Sx**		XY
number of data points	**n**	**n**		XY
standard error about the line			**s**	TEST
regression/fit coefficients			**a, b**	EQ
correlation coefficient			**r**	EQ
coefficient of determination			**r2**	EQ
regression equation			**RegEQ**	EQ

Note: The variables listed above cannot be archived.

Distribution Functions

DISTR menu

To display the DISTR menu, press 2nd [DISTR].

DISTR DRAW

1:	normalpdf(	*nn* probability density function
2:	normalcdf(	*nn* cumulative distribution function
3:	invNorm(	Inverse cumulative normal distribution
4:	invT(	Inverse cumulative Student-*t* distribution
5:	tpdf(	Student-*t* probability density
6:	tcdf(	Student-*t* distribution probability
7:	χ^2pdf(	Chi-square probability density
8:	χ^2cdf	Chi-square distribution probability
9:	**F**pdf(	**F**probability density
0:	**F**cdf(	**F**distribution probability
A:	binompdf(	Binomial probability

`DISTR DRAW`		
`B:`	`binomcdf(`	Binomial cumulative density
`C:`	`poissonpdf(`	Poisson probability
`D:`	`poissoncdf(`	Poisson cumulative density
`E:`	`geometpdf(`	Geometric probability
`F:`	`geometcdf(`	Geometric cumulative density

Note: ⁻1E99 and 1E99 specify infinity. If you want to view the area left of *upperbound*, for example, specify *lowerbound*=⁻1E99.

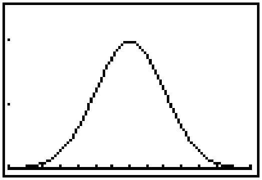
normalpdf(

normalpdf(computes the probability density function (**pdf**) for the normal distribution at a specified *x* value. The defaults are mean μ=0 and standard deviation σ=1. To plot the normal distribution, paste **normalpdf(** to the Y= editor. The probability density function (pdf) is:

$$f(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(x-\ )^2}{2\sigma^2}}, \sigma > 0$$

normalpdf(x[,μ,σ]**)**

```
  Plot1  Plot2  Plot3
\Y1■normalpdf(X,
35,2)
```



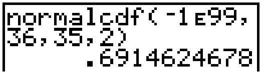
Note: For this example,
Xmin = 28
Xmax = 42
Ymin = 0
Ymax = .2
Xscl = 1
Yscl = .1

Note: For plotting the normal distribution, you can set window variables **Xmin** and **Xmax** so that the mean μ falls between them, and then select **0:ZoomFit** from the **ZOOM** menu.

normalcdf(

normalcdf(computes the normal distribution probability between *lowerbound* and *upperbound* for the specified mean μ and standard deviation σ. The defaults are μ=0 and σ=1.

normalcdf(*lowerbound*,*upperbound*[,μ,σ]**)**

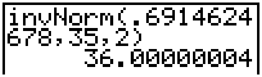


```
normalcdf(-1E99,
36,35,2)
      .6914624678
```

invNorm(

invNorm(computes the inverse cumulative normal distribution function for a given *area* under the normal distribution curve specified by mean μ and standard deviation σ. It calculates the *x* value associated with an *area* to the left of the *x* value. 0 ≤ *area* ≤ 1 must be true. The defaults are μ=0 and σ=1.

invNorm(*area*[,μ,σ]**)**

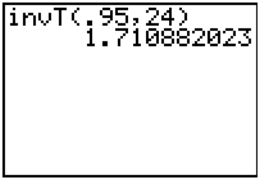


```
invNorm(.6914624
678,35,2)
      36.00000004
```

invT(

invT(computes the inverse cumulative Student-t probability function specified by Degree of Freedom, df for a given Area under the curve.

invT(*area*,*df***)**



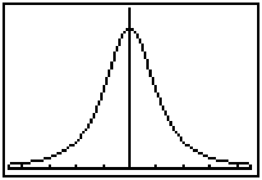
```
invT(.95,24)
      1.710882023
```

tpdf(computes the probability density function (**pdf**) for the Student-*t* distribution at a specified *x* value. *df* (degrees of freedom) must be > 0. To plot the Student-*t* distribution, paste **tpdf(** to the Y= editor. The probability density function (**pdf**) is:

$$f(x) = \frac{\Gamma[(df+1)/2]}{\Gamma(df\ \ 2)} \quad \frac{(1+x^2/df)^{-(df+1)/2}}{\sqrt{\pi df}}$$

tpdf(*x*,*df***)**

```
 Plot1 Plot2 Plot3
\Y1=tpdf(X,2)
```



Note: For this example,
Xmin = ⁻4.5
Xmax = 4.5
Ymin = 0
Ymax = .4

tcdf(

tcdf(computes the Student-*t* distribution probability between *lowerbound* and *upperbound* for the specified *df* (degrees of freedom), which must be > 0.

tcdf(*lowerbound*,*upperbound*,*df***)**

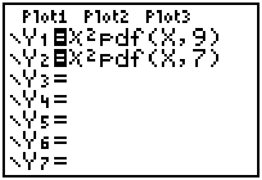
```
tcdf(⁻2,3,18)
       .9657465644
```

χ^2pdf(

χ^2**pdf(** computes the probability density function (**pdf**) for the χ^2 (chi-square) distribution at a specified x value. df (degrees of freedom) must be an integer > 0. To plot the χ^2 distribution, paste χ^2**pdf(** to the Y= editor. The probability density function (**pdf**) is:

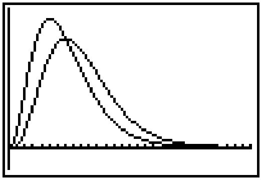
$$f(x) = \frac{1}{\Gamma(df/2)}(1/2)^{df/2}x^{df/2-1}e^{-x/2}, x \geq 0$$

χ^2**pdf(**x**,**df**)**



```
  Plot1  Plot2  Plot3
\Y1=χ²pdf(X,9)
\Y2=χ²pdf(X,7)
\Y3=
\Y4=
\Y5=
\Y6=
\Y7=
```

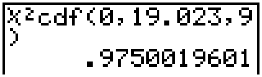
Note: For this example,
Xmin = 0
Xmax = 30
Ymin = ⁻.02
Ymax = .132



χ^2cdf(

χ^2**cdf(** computes the χ^2 (chi-square) distribution probability between *lowerbound* and *upperbound* for the specified *df* (degrees of freedom), which must be an integer > 0.

χ^2**cdf(***lowerbound***,***upperbound***,***df***)**



```
χ²cdf(0,19.023,9
)
     .9750019601
```

Fpdf(

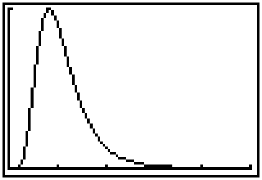
Fpdf(computes the probability density function (**pdf**) for the **F** distribution at a specified *x* value. *numerator df* (degrees of freedom) and *denominator df* must be integers > 0. To plot the **F** distribution, paste **Fpdf(** to the Y= editor. The probability density function (**pdf**) is:

$$f(x) \;=\; \frac{\Gamma[(n+d)/2]}{\Gamma(n/2)\Gamma(d/2)}\left(\frac{n}{d}\right)^{n/2} x^{n/2-1}(1+nx/d)^{-(n+d)/2}, x \geq 0$$

where n = numerator degrees of freedom
d = denominator degrees of freedom

Fpdf(*x*,*numerator df*,*denominator df***)**

```
 Plot1  Plot2  Plot3
\Y1=Fpdf(X,24,19
)■
```

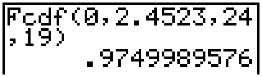


Note: For this example,
Xmin = 0
Xmax = 5
Ymin = 0
Ymax = 1

Fcdf(

Fcdf(computes the **F** distribution probability between *lowerbound* and *upperbound* for the specified *numerator df* (degrees of freedom) and *denominator df*. *numerator df* and *denominator df* must be integers > 0.

Fcdf(*lowerbound*,*upperbound*,*numerator df*,*denominator df***)**



```
Fcdf(0,2.4523,24
,19)
      .9749989576
```

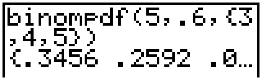
binompdf

binompdf(computes a probability at *x* for the discrete binomial distribution with the specified *numtrials* and probability of success (*p*) on each trial. *x* can be an integer or a list of integers. 0≤*p*≤1 must be true. *numtrials* must be an integer > 0. If you do not specify *x*, a list of probabilities from 0 to *numtrials* is returned. The probability density function (**pdf**) is:

$$f(x) = \binom{n}{x} p^{x}(1-p)^{n-x}, x = 0,1,\ldots,n$$

where $n = numtrials$

binompdf(*numtrials*,*p*[,*x*]**)**

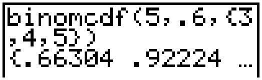


```
binompdf(5,.6,{3
,4,5})
{.3456 .2592 .0…
```

binomcdf(

binomcdf(computes a cumulative probability at *x* for the discrete binomial distribution with the specified *numtrials* and probability of success (*p*) on each trial. *x* can be a real number or a list of real numbers. 0≤*p*≤1 must be true. *numtrials* must be an integer > 0. If you do not specify *x*, a list of cumulative probabilities is returned.

binomcdf(*numtrials*,*p*[,*x*]**)**



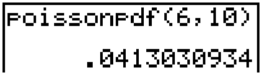
```
binomcdf(5,.6,{3
,4,5})
{.66304 .92224 …
```

poissonpdf(

poissonpdf(computes a probability at x for the discrete Poisson distribution with the specified mean μ, which must be a real number > 0. x can be an integer or a list of integers. The probability density function (**pdf**) is:

$$f(x) = e^{-} \quad {}^{x} \quad x!, x = 0,1,2,\ldots$$

poissonpdf(μ,x**)**

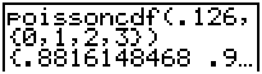


```
poissonpdf(6,10)
      .0413030934
```

poissoncdf(

poissoncdf(computes a cumulative probability at x for the discrete Poisson distribution with the specified mean μ, which must be a real number > 0. x can be a real number or a list of real numbers.

poissoncdf(μ,x**)**



```
poissoncdf(.126,
{0,1,2,3})
{.8816148468 .9…
```

geometpdf(

geometpdf(computes a probability at x, the number of the trial on which the first success occurs, for the discrete geometric distribution with the specified probability of success p.

0≤*p*≤1 must be true. *x* can be an integer or a list of integers. The probability density function (pdf) is:

$$f(x) = p(1-p)^{x-1}, x = 1,2,\ldots$$

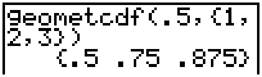
geometpdf(*p***,***x***)**

```
geometpdf(.4,6)
          .031104
```

geometcdf(

geometcdf(computes a cumulative probability at *x*, the number of the trial on which the first success occurs, for the discrete geometric distribution with the specified probability of success *p*. 0≤*p*≤1 must be true. *x* can be a real number or a list of real numbers.

geometcdf(*p***,***x***)**



```
geometcdf(.5,{1,
2,3})
   {.5 .75 .875}
```

Distribution Shading

DISTR DRAW Menu

To display the **DISTR DRAW** menu, press [2nd] [DISTR] [▸]. **DISTR DRAW** instructions draw various types of density functions, shade the area specified by *lowerbound* and *upperbound*, and display the computed area value.

To clear the drawings, select **1:ClrDraw** from the **DRAW** menu (Chapter 8).

Note: Before you execute a **DISTR DRAW** instruction, you must set the window variables so that the desired distribution fits the screen.

DISTR DRAW		
1:	`ShadeNorm(`	Shades normal distribution.
2:	`Shade_t(`	Shades Student-*t* distribution.
3:	`Shade`χ^2`(`	Shades χ^2 distribution.
4:	`ShadeF(`	Shades F distribution.

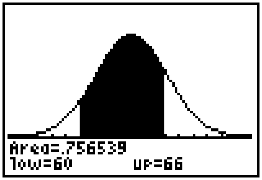
Note: ⁻1E99 and 1E99 specify infinity. If you want to view the area left of *upperbound*, for example, specify *lowerbound*=⁻1E99.

ShadeNorm(

ShadeNorm(draws the normal density function specified by mean μ and standard deviation σ and shades the area between *lowerbound* and *upperbound*. The defaults are μ=0 and σ=1.

ShadeNorm(*lowerbound*,*upperbound*[,μ,σ]**)**

```
ShadeNorm(60,66,
63.6,2.5)
```



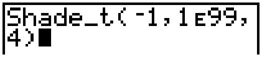
```
Area=.756539
low=60      up=66
```

Note: For this example,
Xmin = 55
Xmax = 72
Ymin = ⁻.05
Ymax = .2

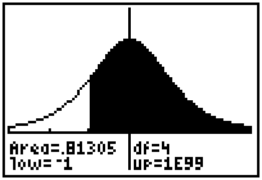
Shade_t(

Shade_t(draws the density function for the Student-*t* distribution specified by *df* (degrees of freedom) and shades the area between *lowerbound* and *upperbound*.

Shade_t(*lowerbound*,*upperbound*,*df***)**



```
Shade_t(⁻1,1E99,
4)
```



```
Area=.81305  df=4
low=⁻1       up=1E99
```

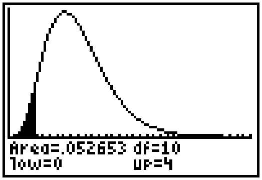
Note: For this example,
Xmin = ⁻3
Xmax = 3
Ymin = ⁻.15
Ymax = .5

Shadeχ^2(

Shadeχ^2(draws the density function for the χ^2 (chi-square) distribution specified by *df* (degrees of freedom) and shades the area between *lowerbound* and *upperbound*.

Shadeχ^2(*lowerbound***,***upperbound***,***df***)**

```
Shadeχ²(0,4,10)
```



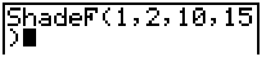
Area=.052653 df=10
low=0 up=4

Note: For this example,
Xmin = 0
Xmax = 35
Ymin = ⁻.025
Ymax = .1

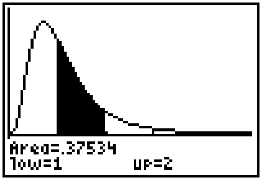
ShadeF(

ShadeF(draws the density function for the **F** distribution specified by *numerator df* (degrees of freedom) and *denominator df* and shades the area between *lowerbound* and *upperbound*.

ShadeF(_lowerbound_**,**_upperbound_**,**_numerator df_**,**_denominator df_**)**



```
ShadeF(1,2,10,15
)
```



```
Area=.37534
low=1       up=2
```

Note: For this example,
Xmin = 0
Xmax = 5
Ymin = ⁻.25
Ymax = .9