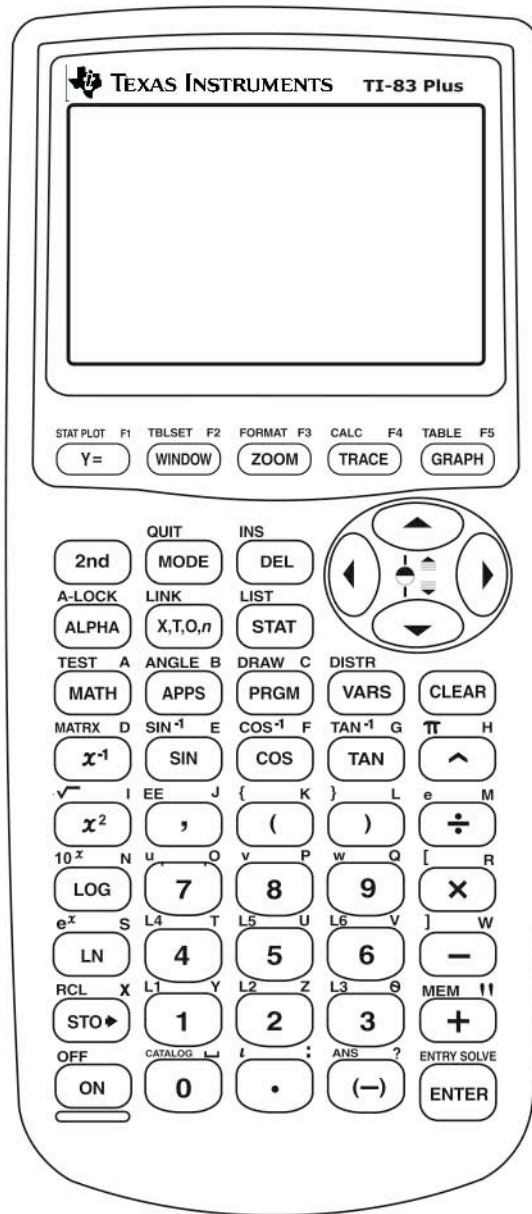# USING A TI-83 OR TI-84 SERIES GRAPHING CALCULATOR
IN AN INTRODUCTORY STATISTICS CLASS

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Getting to Know Your TI-83/84

Press ON to begin using calculator. To stop, press 2nd ON [OFF]. To darken the screen, press 2nd ▲ alternately. To lighten the screen, press 2nd ▼ alternately. Press 2nd + [MEM] to reset or clear the memory of the calculator.

1. ENTER works as the equals key
2. 2nd permits access to the yellow options above the keys
3. ALPHA permits access to the green alphabetic letters above the keys
4. 2nd ALPHA [A-LOCK] alphabetic letter lock
5. X,T,Θ,*n* prints X in function mode; prints T in parametric mode; prints θ in polar mode; prints *n* in sequence graphing mode
6. ^ is the exponent key (raises to the power entered next)
7. [␣] is the alphabetic space key (in green, above 0)
8. 2nd ^ [π] enters the numerical constant
9. (-) is the negative key
10. 2nd (-) [ANS] recalls the last answer
11. 2nd ENTER [ENTRY] recalls the most previous entry (repeat for more previous entries)
12. DEL deletes the character marked by the cursor
13. 2nd DEL [INS] permits insertion of a character at the position before the cursor
14. MODE sets various modes of calculator   At present, your calculator should have the following settings highlighted: Normal, Float, Radian, Function, Connected, Sequential, Real, Full
15. MATH (options)   1. display answer as a fraction
    2. display answer as a decimal
    3. cube a number
    4. take the cube root of a number
    5. take the xth root of a number
    6. minimum of a function
    7. maximum of a function
    8. numerical derivative
    9. function integral
    0. solves for any variable in an equation

16.　[PRGM] EXEC EDIT NEW (for executing, editing, and creating programs)

Program #1: **OWNER** *(Identifies to whom the calculator belongs.)*

What Needs to be Done:	TI Syntax: PROGRAM: OWNER	How Accessed? [PRGM][▶][▶] (for NEW) [ENTER] [O][W][N][E][R] [ENTER]
1. Clears the Home Screen	:ClrHome	[PRGM][▶] (for I/O) [8] [ENTER]
2. Displays your name.	:Disp "*your name*"	[PRGM][▶][3][2nd][ALPHA][+] (letters of your name) [+] [ENTER]

NOTE: Blank space [␣] is [ALPHA][0]

3. Displays your telephone number.	:Disp "###-####" Insert your actual phone number within the quotes.	[PRGM][▶][3][ALPHA][+] (actual phone number) [ALPHA][+][ENTER]
4. Stops program.	:Stop	[PRGM] F [ENTER] (F is [ALPHA][COS])
5. Return to Home Screen		[2nd][MODE] (for [QUIT])

Execute the program by pressing [PRGM], select "OWNER", press [ENTER], and press [ENTER]

17.　[2nd][PRGM] (for [DRAW])
　　　　　1. Clr draw
　　　　　2. Line
　　　　　3. Horizontal
　　　　　4. Vertical
　　　　　5. Tangent
　　　　　6. Draw function
　　　　　7. Shade
　　　　　8. Draw inverse
　　　　　9. Draw circle
　　　　　0. adds text to graph
　　　　　A. free-form drawing tool

Graphing keys - top row of calculator

1.　　[Y=] allows you to enter up to ten separate equations
2.　　[WINDOW] sets dimensions of viewing rectangle
3.　　[ZOOM] allows you to adjust the viewing rectangle
4.　　[TRACE] allows you to find a specific point on a graph
5.　　[GRAPH] draws the graph of a function

**Using the viewing rectangle**

The viewing rectangle on the TI-83 is 94 pixels by 62 pixels. (A pixel is a picture element.) It is useful when graphing to have a "friendly window" in order to avoid distortion in the graph and to avoid obtaining non-integer values when using the trace function of the TI-83. In fact, [ZOOM][9] (ZoomStat) usually gives a "friendly window".

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Data, Graphs, and Univariate Statistics in the TI-83/84

I. Entering Data

1. Press the $\boxed{\text{STAT}}$ button then under the EDIT on-screen menu select 1:Edit…

2. You should get a window that looks like this:
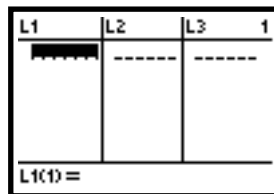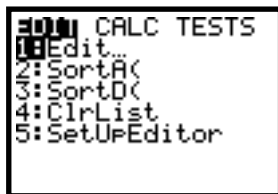
    If your lists contain data, you can remove the data in an individual list by moving the cursor up (using $\boxed{\blacktriangle}$) to select the name of the list you want to clear (e.g. L1) and then press the $\boxed{\text{CLEAR}}$ button followed by the $\boxed{\text{ENTER}}$ button. Your list should now be clear.

    To clear the data in all lists, select the MEM command ($\boxed{\text{2nd}}$ $\boxed{+}$) then select 4:ClrAllLists from the on-screen menu. When ClrAllLists appears on the screen, press $\boxed{\text{ENTER}}$. All of your lists should now be clear.

3. Enter your data set into a list (*e.g.* L1) by typing in the first value, press $\boxed{\text{ENTER}}$, then type in the next value, press $\boxed{\text{ENTER}}$, and continue doing so until all values are in the list. Be sure to press $\boxed{\text{ENTER}}$ after *EVERY* data value (including the final value).

    Example: Enter the following data set into L1.

    3 4 2 3 1 1 6 1 2 0 5 1 2 1 0 3 4 0 3 2 0 3 1 1

    After you've entered the data, your screen should look like this:
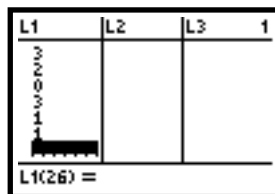
    You should now use the $\boxed{\blacktriangle}$ and $\boxed{\blacktriangledown}$ keys to scroll through your list to be sure that all of the data values were entered correctly (compare your list with the above data set). Replace any incorrect value with the correct value.

4. *Note:* If you have grouped data (data values and frequencies), then you would enter the data values into one list (*e.g.* L3) and the frequencies into the next list (*e.g.* L4).
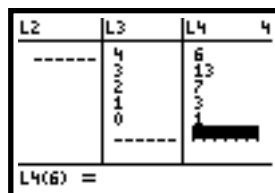
5. If you mistakenly delete one of your six lists (by pressing DEL instead of CLEAR when trying to clear a list), you may retrieve it by pressing STAT then selecting 5:SetUpEditor. When SetUpEditor appears on the screen, press ENTER. Now all of your six lists should be available.

```
█████ CALC TESTS
1:Edit…
2:SortA(
3:SortD(
4:ClrList
5█SetUpEditor
```

```
SetUpEditor
          Done
█
```
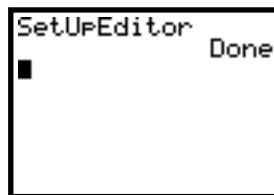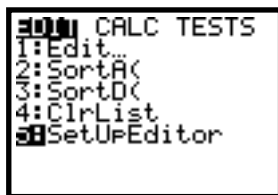
II. Plotting Statistical Graphs

1. First of all, you should be sure that your plotting area is clear. To do so, press Y= and be sure that all ten (Y1 − YØ) of your functions are clear (empty). If a function is not clear, use the ▼ and ▲ keys to move the cursor to that function and press CLEAR to clear it out.

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

```
████ PLOTS
1:Plot1…Off
   ⌐ L3    L4    +
2:Plot2…Off
   ⌐ L1    L2    □
3:Plot3…Off
   ⌐ L1    L2    □
4█PlotsOff
```

```
PlotsOff
          Done
█
```

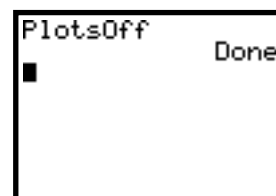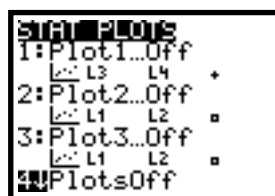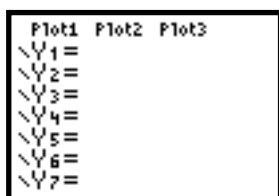If you don't follow the above procedure, you may get the following error. If this error occurs, press ENTER and repeat the above procedure to clear your plots.

```
ERR:DIM MISMATCH
1█Quit
```
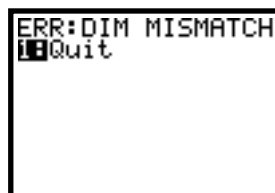
2. Next, be sure that you have no other statistical plots activated. To do so, press [STAT PLOT] (2nd Y=), select option 4:PlotsOff, and press ENTER twice. Now all plots are off.

3. To activate a statistics plot, press [STAT PLOT] (2nd Y=), select option 1:Plot1…Off, and press ENTER. Your screen should look like the second picture, below. The cursor should be blinking over the word On; press ENTER to activate this plot.

```
████ PLOTS
1█Plot1…Off
   ⌐ L3    L4    +
2:Plot2…Off
   ⌐ L1    L2    □
3:Plot3…Off
   ⌐ L1    L2    □
4↓PlotsOff
```

```
████ Plot2  Plot3
On  Off
Type: ▥  ⌐⌐  ⊞⊞⊞
      ▥⊷  ▥⊞  ⌐
Xlist:L3
Ylist:L4
Mark: □  ■  ·
```

Use the ▼ key to move the cursor down to the Type: of graph setting. Use the ▶ and ◀ keys to move the cursor to the desired graph. Once that graph is highlighted, press ENTER to select it. The types of graphs available are: ⌐⌐ (scatterplot), ⌐△ (line plot or trend graph), ⊞⊞⊞ (histogram), ⊡⁃⁃ (modified boxplot—shows outliers), STAT (basic boxplot—doesn't show outliers), and ⌐⌐ (normal probability plot). After the type of graph has been selected, be sure to select the remaining options (options differ for each graph type).

4. *Frequency Histograms (all data values are in one list):* If all of your data values are in one list (*e.g.* L1), you can easily create a frequency histogram. Follow steps II.1–II.3 above and select ⊞ as your Type:. Press the ▼ key to move to Xlist:. Note that your cursor is in ALPHA mode. Be sure to enter the list number that contains your data; for example, using the list of values from I.3 above we'd select L1 (2nd 1). Press ▼ to move to Freq:. Since all of our data is in one list, we enter 1 here. (Note: The cursor is in ALPHA mode, so you'll need to press ALPHA to leave ALPHA mode in order to enter a numerical value.)

Now you must set the window size, so you can see the graph properly. To do so, press WINDOW. Now you must enter the dimensions of your graph. For Xmin=, enter the lower limit of the first class. For Xmax=, enter a value slightly larger than the upper limit of the last class. For Xscl=, enter the class width. For Ymin=, enter -1. For Ymax=, enter a value slightly larger than the highest frequency. For Yscl=, enter 1. For Xres=, enter 1.
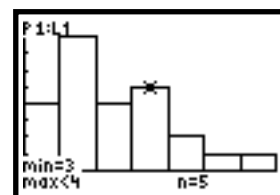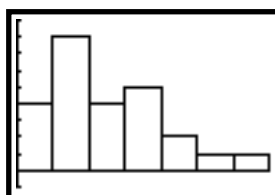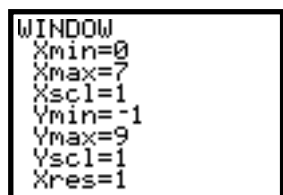
To view the resulting frequency histogram, simply press GRAPH (see above, middle). To determine the actual class limits and frequencies, just press TRACE and use the ▶ and ◀ keys to move the cursor across each bar. The values in the upper left corner indicate the plot number (P1) and which list is plotted (L1). The values in the lower left corner indicate the lower class limit and upper class limit for the selected bar (the bar under the cursor). Finally, the frequency of the selected bar/class is indicated in the lower right corner (in the example above, there are 5 occurrences of the number 3 in our data set).

5. *Histograms of Grouped Data:* If you have grouped data (data values with frequencies or relative frequencies), such that the data values are in one list (*e.g.* L3) and the frequencies (or relative frequencies) are in the next list (*e.g.* L4), then the procedure for the histogram would be the same as II.4 above, except that Xlist: would be the list of values (*e.g.* L3) and Freq: would be the list of frequencies (or relative frequencies) (*e.g.* L4).

If you have relative frequencies instead of frequencies (*i.e.,* you plot a relative frequency histogram), be sure that for Ymin= you enter -0.1 and for Ymax= you enter 1.

6. *Boxplots:* Follow steps II.1–II.3 above and select ⊡⊢ as your Type:. Press ▼ to move to Xlist:. Note that your cursor is in ALPHA mode. Be sure to enter the list number that contains your data values; for example, using the list of values from I.3 above we'd select L1 (2nd 1). Press ▼ to move to Freq:. Since all of this data is in one list, we enter 1 here (see left graph below). (Note: The cursor is in ALPHA mode, so you'll need to press ALPHA to leave ALPHA mode in order to enter a numerical value.) If you had grouped data (see right graph below), Xlist: would be the list of values (*e.g.* L3) and Freq: would be the list of frequencies (or relative frequencies) (*e.g.* L4).

Now you must set the window size, so you can see the graph properly. To do so, press ZOOM. To select appropriate dimensions, simply select 9:ZoomStat to view the boxplot. To see your five number summary, press TRACE and move the cursor across the plot.
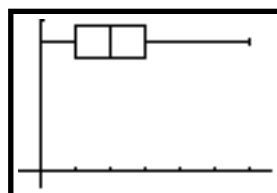
7. *Modified Boxplots:* Follow steps II.1–II.3 above and select ⊡⁚⁚ as your Type:. Press ▼ to move to Xlist:. Note that your cursor is in ALPHA mode. Be sure to enter the list number that contains your data; for example, using the list of values from I.3 above we'd select L1 (2nd 1). Press ▼ to move to Freq:. Since all of this data is in one list, we enter 1 here (see left graph below). (Note: The cur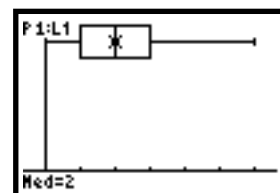sor is in ALPHA mode, so you'll need to press ALPHA to leave ALPHA mode in order to enter a numerical value.) If you had grouped data (see right graph below), Xlist: would be the list of values (*e.g.* L3) and Freq: would be the list of frequencies (or relative frequencies) (*e.g.* L4). Now select Mark: to be the middle symbol (+) to indicate outliers.

Now you must set the window size, so you can see the graph properly. To do so, press ZOOM. To select appropriate dimensions, simply select 9:ZoomStat to view the boxplot. You can press TRACE and move the cursor across the plot to see the values for the plot and any outliers.

III. *Univariate Statistics (Statistics for One Variable)*

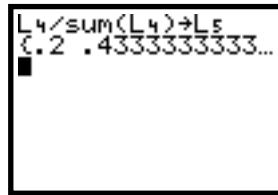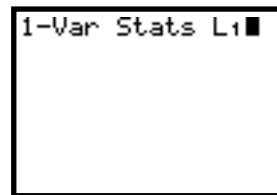1. *Relative Frequencies:* If you have grouped data (data values and frequencies), then you would enter the data values into one list (*e.g.* L3) and the corresponding frequencies into the next list (*e.g.* L4). You can use this information to compute the relative frequencies and store them in L5 using the following procedure from the main screen:

   CLEAR   2nd 4   ÷   2nd STAT ▶ ▶ 5:sum(ENTER   2nd 4   )   1   2nd 5   ENTER

   ```
   L4/sum(L4)→L5
   {.2 .4333333333…
   ■
   ```

   ```
   L3    |L4    |L5      5
   4     |6     |.2
   3     |13    |.43333
   2     |7     |.23333
   1     |3     |.1
   0     |1     |.03333
   ------|------|------
   L5(6) =
   ```

2. *Sample Mean, Standard Deviation, $\sum x$, $\sum x^2$, Sample Size, and Five-Number Summary:* If all of your data values are in one list, press STAT then press ▶ to get to the CALC menu and select the first option, 1:1-Var Stats. Now enter the name of the list that contains the data (*e.g.* L1— 2nd 1) and press ENTER.

   ```
   EDIT CALC TESTS
   1■1-Var Stats
   2:2-Var Stats
   3:Med-Med
   4:LinReg(ax+b)
   5:QuadReg
   6:CubicReg
   7↓QuartReg
   ```

   ```
   1-Var Stats L1■
   ```
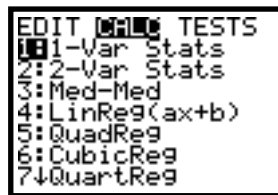
   Note the arrow pointing down on the left side…this arrow indicates that there is more information; you can access this information by scrolling with the ▼ and ▲ keys. If you have a sample, standard deviation is Sx; if you have a census (sample = population), standard deviation is σx.

   ```
   1-Var Stats
   x̄=2
   Σx=50
   Σx²=162
   Sx=1.607275127
   σx=1.574801575
   ↓n=25
   ```

   ```
   1-Var Stats
   ↑n=25
   minX=0
   Q₁=1
   Med=2
   Q₃=3
   maxX=6
   ■
   ```
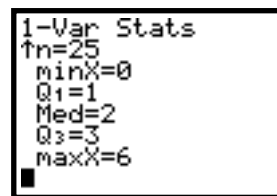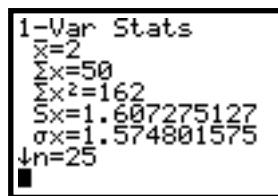
3. *Sample Mean, Standard Deviation, $\sum x$, $\sum x^2$, Sample Size, and Five-Number Summary:* If you have grouped data (data values and frequencies), then you would enter the data values into one list (*e.g.* L3) and the corresponding frequencies into the next list (*e.g.* L4). To obtain the statistics, press STAT then press ▶ to get to the CALC menu and select the first option, 1:1-Var Stats. Now enter the name of the list that contains the data (*e.g.* L3— 2nd 3) followed by , and the name of the list that contains the frequencies (*e.g.* L4— 2nd 4). Finally, press ENTER.

   ```
   EDIT CALC TESTS
   1■1-Var Stats
   2:2-Var Stats
   3:Med-Med
   4:LinReg(ax+b)
   5:QuadReg
   6:CubicReg
   7↓QuartReg
   ```

   ```
   1-Var Stats L3,L
   4■
   ```
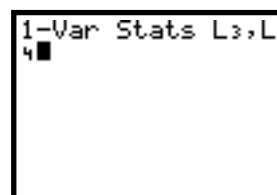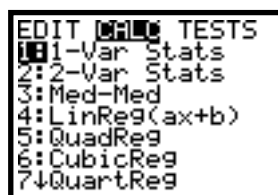
Normal Distribution Methods in the TI-83/84

I. *Normal Probabilities*

1. Normal probabilities can be computed using formulas and a Standard Normal Table, or they can be computed directly with the TI-83. Use [2nd][VARS] [DISTR] and scroll down to 2:normalcdf(and press [ENTER], then enter the values for *lower-limit, upper-limit, mean*, and *standard-deviation* followed by and [ENTER] (see example, below).

2. For example, suppose you want to find the probability that a standard normal random variable is between -1 and 1 (according to the text, this should be about 0.68); that is, find $P(-1 < z < 1)$ when $\mu = 0$ and $\sigma = 1$. To find this probability, simply follow the following steps: press [2nd][VARS] [DISTR] scroll down to 2:normalcdf(and press [ENTER] (left & middle screens), then enter [(-)][1][,][1][,][0][,][1] followed by and [ENTER] (right screen). Note that our answer is slightly off from a textbook's table value; that value has rounding error.

```
DISTR DRAW
1:normalpdf(
2:normalcdf(
3:invNorm(
4:tpdf(
5:tcdf(
6:X²pdf(
7↓X²cdf(
```
```
normalcdf(
```
```
normalcdf(-1,1,0
,1)
        .6826894809
```

3. To find the probability that a normal random variable with a mean of 12 and a standard deviation of 4.6 is less than 5.62; that is, find $P(x < 5.62)$ when $\mu = 12$ and $\sigma = 4.6$. You can either find the *z*-score of 5.62 and use Table A, or you can use the TI-83 with a lower limit of negative infinity (approximately -1E99) and an upper limit of 5.62. To find this probability, simply follow the following steps: press [2nd][VARS] [DISTR] scroll down to 2:normalcdf(and press [ENTER] (left & middle screens), then enter [(-)][1][2nd][,][EE][9][9][,][5][.][6][2][,][1][2][,][4][.][6] followed by and [ENTER] (right screen).

```
DISTR DRAW
1:normalpdf(
2:normalcdf(
3:invNorm(
4:tpdf(
5:tcdf(
6:X²pdf(
7↓X²cdf(
```
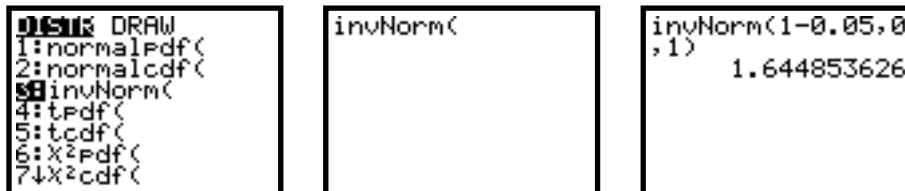```
normalcdf(
```
```
normalcdf(-1E99,
5.62,12,4.6)
        .0827275649
```

Thus, $P(x < 5.62)$ is about 0.0827, or about 8.27% of the observations are less than 5.62. Note that if you have an upper limit of infinity, you should approximate it with 1E99.

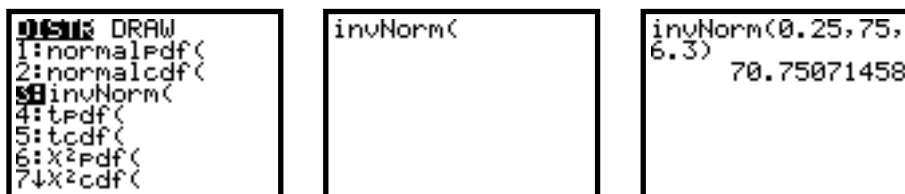II. *Finding a Z-score for a Specified Area (i.e., Finding $Z_\alpha$)*

1. Inverse normal probabilities, *e.g.* finding $Z_\alpha$ such that $P(z \geq Z_\alpha) = \alpha$, can be computed directly with the TI-83 (thus avoiding the need to use formulas and a Standard Normal Table). Use [2nd][VARS] [DISTR] scroll down to 3:invNorm( and press [ENTER], then enter the values for 1-$\alpha$, $\mu$, and $\sigma$ followed by and [ENTER] (see example, below).

2. For example, suppose you want to find $Z_{0.05}$. Using a Standard Normal Table, this value is found to be about 1.645. To find the value of $Z_{0.05}$ using the TI-83, simply follow the following steps: press [2nd][VARS] [DISTR] scroll down to 3:invNorm( and press [ENTER] (left & middle screens), then enter [1][-][0][.][0][5][,][0][,][1] followed by and [ENTER] (right screen).

```
DISTR DRAW        invNorm(          invNorm(1-0.05,0
1:normalpdf(                        ,1)
2:normalcdf(                              1.644853626
3:invNorm(
4:tpdf(
5:tcdf(
6:X²pdf(
7↓X²cdf(
```

Thus, 1.645 is the value of the standard normal random variable that has area under the standard normal curve to the right equal to 0.05 (and area to the left equal to 0.95).

III. *Finding Observations for a Specified Percentage or Area*

1. Inverse normal probabilities, *e.g.* finding X such that $P(x \geq X) = \alpha$, can be computed directly with the TI-83 (thus avoiding the need to use the *z*-score formula with Table A). Use [2nd][VARS] [DISTR] scroll down to 3:invNorm(and press [ENTER], then enter the values for 1-α, μ, and σ followed by and [ENTER] (see example, below).

2. For example, suppose you want to find the score below which 25% of the class scored on a test (the 25th percentile of scores) where the scores are normally distributed with a mean of 75 and a standard deviation of 6.3; that is, you want to find X such that $P(score \leq X) = 0.25$ (1-α = 0.25, so α = 0.75). To find the value of X using the TI-83, simply follow the following steps: press [2nd][VARS] [DISTR] scroll down to 3:invNorm(and press [ENTER] (left & middle screens), then enter [0][.][2][5][,][7][5][,][6][.][3] followed by and [ENTER] (right screen).

```
DISTR DRAW        invNorm(          invNorm(0.25,75,
1:normalpdf(                        6.3)
2:normalcdf(                              70.75071458
3:invNorm(
4:tpdf(
5:tcdf(
6:X²pdf(
7↓X²cdf(
```

Thus, 25% of the students scored below 70.75 on the test (75% scored above 70.75); in other words, the first quartile (Q1) of the scores is 70.75.

IV. *Assessing Normality of Data (Normal Probability Plots)*

1. In order to determine if data values are normally distributed, these values are plotted in a scatterplot versus their normal scores (what the *z*-scores of the data values should be if they are normally distributed). If the points lie about a diagonal line, then the data values are approximately normally distributed. If a data value lies far to the left or to the right of the pattern of the points, then that value might be an outlier.

2. For example, suppose you want to determine if the following data values {9.7, 93.1, 33.0, 21.2, 81.4, 51.1, 43.5, 10.6, 12.8, 7.8, 18.1, 12.7} are normally distributed. First enter the values into a list (say L1). Now, press 2nd ZOOM for FORMAT and select AxesOff (see left screen image). Press Y= and be sure that all of the plots are off, then select 2nd Y= for STAT PLOT. Be sure that Plot1 is the only plot on, then move the cursor to Plot1 and press ENTER to set the plot options. The plot should be On, the Type: should be set for normal plots (⌐), the Data List: should be the list of data values (L1), the Data Axis: should be Y, and the Mark: should be +. Now, press ZOOM and select 9:ZoomStat to see the normal probability plot (see right screen image).
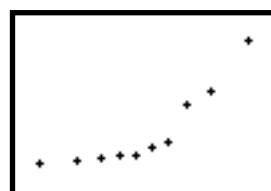
Since we see a concave-up curve (rightside-up bowl shape), we see that our data isn't normally distributed—it is left-skewed. Since all of the points appear to be along the curved line, there are no apparent outliers.

3. As a second example, suppose you want to determine if the following data values {47, 39, 62, 49, 50, 70, 59, 53, 55, 65, 63, 53, 51, 50, 72, 45} are normally distributed. First enter the values into a list (say L2). Now, set the plot options for Plot1 using L2 for the Data List:. Now, press ZOOM and select 9:ZoomStat to see the normal probability plot (see right screen image).
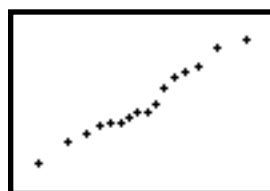
Since we see a diagonal linear pattern, we see that our data is approximately normally distributed. Since all of the points appear to be along the diagonal line, there are no apparent outliers.

Regression Methods in the TI-83/84

I. *Creating Scatterplots*

1. First enter the explanatory variable (*x*) data into L1 and enter the response variable (*y*) data into L2. (You can use different lists to store the data, but we'll just use lists L1 and L2 for simplicity.)

   Example: An article read by a physician indicated that the maximum heart rate an individual can reach during intensive exercise decreases with age. They physician decided to do his own study. Ten randomly selected people performed exercise tests and recorded their peak heart rates. The results are shown below, where *x* denotes age in years and *y* denotes peak heart rate.

x	30	38	41	38	29	39	46	41	42	24
y	186	183	171	177	191	177	175	176	171	196

2. Next, you should be sure that your plotting area is clear. To do so, press Y= and be sure that all ten (Y1 − YØ) of your functions are clear (empty). If a function is not clear, use the arrow keys to move the cursor to that function and press CLEAR to clear it out.
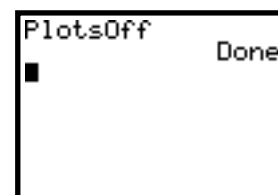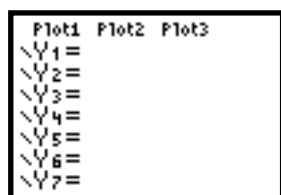
   If you don't follow the above procedure, you may get the following error. If this error occurs, press ENTER and repeat the above procedure to clear your plots.
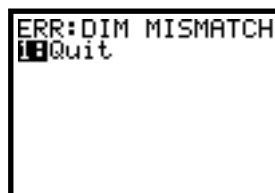
3. Next, be sure that you have no other statistical plots activated. To do so, press STATPLOT (2nd Y=), select option 4:PlotsOff, and press ENTER twice. Now all plots are off.

4. To activate a statistics plot, press STATPLOT (2nd Y=), select option 1:Plot1…Off, and press ENTER. Your screen should look similar to the second picture, below. The cursor should be blinking over the word On; press ENTER to activate this plot.

   Use down-arrow to move the cursor down to the Type: of graph setting. Use the ▶ and ◀ keys to move the cursor to the desired graph: (scatterplot). Press ENTER to select scatterplot.

For `Xlist:` enter the list that contains the explanatory variable data (`L1`). For `Ylist:` enter the list that contains the response variable data (`L2`). Now choose your plotting `Mark:` (the middle selection is usually the best one to use). To see your scatterplot, press ZOOM then select `9:ZoomStat`. If your graph appears to be linear, then compute the correlation coefficient to determine if it is "linear enough."
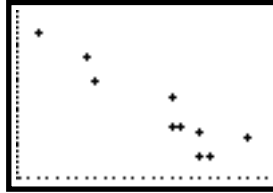
The example scatterplot shows the points clustering closely about an imaginary line with a negative slope (as age increases, peak heart rate decreases). Therefore, the correlation coefficient (*r*) should be computed to determine if further analysis should be performed.

II. *Bivariate Statistics (Statistics for Two Variables)*

1. Be sure that the data has been entered as prescribed in I.1, above. Press STAT then press ▶ to get to the `CALC` menu and select the second option, `2:2-Var Stats`. Now enter the name of the list that contains the explanatory variable data (*e.g.* `L1`—2nd 1) followed by , and the name of the list that contains the response variable data (*e.g.* `L2`—2nd 2). Finally, press ENTER.

Note the arrow on the left side…this arrow indicates that there is more information; you can access this information by scrolling with the ▼ and ▲ keys. If you have a sample, the standard deviations are `Sx` and `Sy`; if you have a census, standard deviations are σx are σy.

III. *Least-Squares Linear Regression*

1. The first step is to be sure that your TI-83 diagnostics are turned on (required for automatic computation of the correlation coefficient and the coefficient of determination. To turn on the diagnostics, first press [CATALOG] ([2nd][0]) to get a listing of all of the TI-83 commands. Note that the ⌂ symbol is in the upper-left corner; this indicates that you can press one of the keys with green alphabetic letter options to jump directly to the section of the list of commands that begin with that alphabetic letter. Press D ([x⁻¹]) to jump to the commands that begin with the letter "D." Now use the [▼] key to scroll down to DiagnosticOn.

```
CATALOG          ⌂
▶abs(
 and
 angle(
 ANOVA(
 Ans
 augment(
 AxesOff
```
```
CATALOG          ⌂
▶dbd(
  ▶Dec
 Degree
 DelVar
 DependAsk
 DependAuto
 det(
```
```
CATALOG          ⌂
 DependAsk
 DependAuto
 det(
 DiagnosticOff
▶DiagnosticOn
 dim(
 Disp
```

Now press [ENTER] and then press [ENTER] a second time.

```
DiagnosticOn■
```
```
DiagnosticOn
            Done
■
```

2. To automatically compute the least-squares regression line coefficients, the coefficient of determination, and the correlation coefficient, you must use the following procedure. First press [STAT] then press [▶] to get to the CALC menu and select the second option, 8:LinReg(a+bx)…DO NOT select option 4 (your coefficients will be incorrect). Now enter the name of the list that contains the explanatory variable data (*e.g.* L1) followed by [,] and the name of the list that contains the response variable data (*e.g.* L2) followed by [,]. Now we enter the variable we want to contain the resulting equation (press [VARS] then [▶] to select Y-VARS; select 1:Function and press [ENTER]; then select the function you want to use, say 1:Y₁, and press [ENTER]). Finally, press [ENTER] to obtain the results.

```
EDIT CALC TESTS
3↑Med-Med
4:LinReg(ax+b)
5:QuadReg
6:CubicReg
7:QuartReg
8▮LinReg(a+bx)
9↓LnReg
```
```
LinReg(a+bx) L₁,
L₂,Y₁■
```
```
LinReg
 y=a+bx
 a=222.2706767
 b=-1.140507519
 r²=.8621746607
 r=-.9285336077
```

3. To determine if a least-squares regression line should be computed for the data, you must first look at the correlation coefficient (*r*). For this example the correlation coefficient is r=-.9285336077, which means that there is a fairly strong negative linear relationship between age (*x*) and peak heart rate (*y*). This agrees with what we observed from the scatterplot; the scatterplot showed the points clustering closely about an imaginary line with a negative slope. Since we do not have a weak linear relationship, the least-squares linear regression equation should be computed.

4. The format of the linear regression line is given by y=a+bx ($\hat{y} = b_0 + b_1 x$ for some classes), where the y-intercept is a (b_0) and the slope is b (b_1). Be sure to write the actual equation of the line on your assignments. For this example, our equation is:

$$\hat{y} = 222.2706767 + (-1.140507519)x$$

The y-intercept can be interpreted as the initial peak heart rate, or the peak heart rate that corresponds to an age of zero (just born); in this example that would be about 22.2707 beats-per-minute. The slope can be interpreted as the change in y for every one-unit change in x; in this example that would mean that every additional one-year of aging decreases peak heart rate by about 1.1405 beats-per-minute (or changes the peak heart rate by about -1.1405 beats-per-minute).

5. The coefficient of determination for this example (r^2=.862174667) means that about 86.22% of the variation of the peak heart rates (y) is explained by their linear relationship with the ages (x). Since this is a large percentage, any predicted heart rates ($\hat{y}$) that we compute for given ages will be fairly accurate.

6. To predict values of y for specific values of x, you would simply use the least-squares regression line equation while inserting your specified values for x. (Be sure to predict only for values that fall within or near the range of the data…DON'T EXTRAPOLATE!) To predict the peak heart rate of a person who is 30 years old, you would simply enter the following into your TI-83 and then press [ENTER] (recall that we stored the least-squares regression line equation in function Y₁): press [VARS] then [▶] to select Y-VARS; select 1:Function and press [ENTER]; then select the function that contains your least-squares regression line equation (1:Y₁) and press [ENTER]; then press [(] 30 followed by [ENTER]).

```
VARS Y-VARS          VARS Y-VARS          FUNCTION             Y1(30)
1:Window…            1:Function…          1:Y1                        188.0554511
2:Zoom…              2:Parametric…        2:Y2                 ■
3:GDB…               3:Polar…             3:Y3
4:Picture…           4:On/Off…            4:Y4
5:Statistics…                             5:Y5
6:Table…                                  6:Y6
7:String…                                 7↓Y7
```
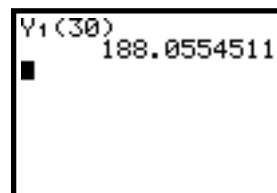
Therefore, the predicted peak heart rate for a person who is 30 years old is about 188.0555 beats-per-minute. This prediction can be performed since 30 years is within the range of our original data (from 24 years to 46 years).

7. To plot the least-squares regression line on your scatterplot, you first must create the scatterplot (see I, above). Then press [Y=] and be sure that Plot1 is active (bolded) and the function for the least-squares regression line is active (the equals sign is bolded, as seen below). Then press [ZOOM] then select 9:ZoomStat to see your original scatterplot with the least-squares regression line added to the plot.

```
Plot1 Plot2 Plot3
\Y1■222.27067669
173+-1.140507518
797X
\Y2=
\Y3=
\Y4=
\Y5=
```
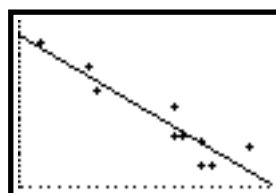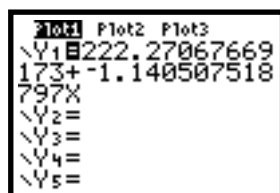
8. To check the residuals to be sure that they are randomly scattered and centered about zero, you must create a residual plot. First, compute the least-squares regression line (see III.2, above). Next, turn off all plots by pressing STATPLOT ([2nd][Y=]), select option 4:PlotsOff, and press [ENTER] twice; plus, press [Y=] and be sure that all ten (Y1 – Y0) of your functions are turned off (equals signs are not bold).

If your graph appears to be randomly scattered about and centered about zero, then the regression seems to be appropriate. If you see a curved pattern, then perhaps a line is not the best model to be using. If you see an increased vertical spread among the points as you move from left to right (as above), then predictions will be more accurate for smaller values of the explanatory variable.

Then, create the residual plot by pressing STATPLOT ([2nd][Y=]), select option 1:Plot1₅OFF, and press [ENTER]. The cursor should be blinking over the word On; press [ENTER] to activate this plot. Use [▼] to move the cursor down to the Type: of graph setting. Use the [▶] and [◀] keys to move the cursor to the desired graph: ⊾ (scatterplot). Press [ENTER] to select scatterplot. For Xlist: enter the list that contains the explanatory variable data (L1). For Ylist: enter the list that contains the computed residuals (RESID). To enter RESID, press [2nd][STAT] [LIST] and select 1:RESID. Now choose your plotting Mark: (the middle selection is usually the best one to use). To see your scatterplot, press [ZOOM] then select 9:ZoomStat.

9. Your final chore is to check that the residuals are approximately normally distributed. To do so, you must create a normal probability plot of the residuals. As long as the resulting points are approximately along a diagonal line, your residuals are approximately normally distributed, thus indicating that your linear regression is appropriate. Now, follow the directions for creating a normal probability plot (Chapter 1, Section 3) by entering in the Data List: the list of residual values (RESID).

Since we see a diagonal line, our residuals are approximately normally distributed. Since all of the points appear to be along the diagonal line, there are no apparent outliers.

Discrete Random Variables in the TI-83/84

I. *Expected Value (Mean) of a Discrete Random Variable*

    1. First enter the values of the random variable into L1 and enter the corresponding probabilities into L2, being sure to keep each probability in the same row with its respective random variable value. (You can use different lists to store the data, but we'll just use lists L1 and L2 for simplicity.)

        Example: Suppose that the distribution of grades (A = 4, B = 3, C = 2, D = 1, F = 0) for a large introductory statistics class is as follows.

Grade	0	1	2	3	4
Probability	0.05	0.10	0.35	0.35	0.15

        Enter the grade value in L1 with the corresponding probabilities in L2.

    2. In order to compute the expected value (or mean) of this discrete random variable, you should press [STAT] then press [▶] to get to the CALC menu and select the first option, 1:1-Var Stats. Now enter the name of the list that contains the values of the discrete random value (*e.g.* L1— [2nd][1]) followed by [,] and the name of the list that contains the corresponding probabilities (*e.g.* L2—[2nd][2]). Finally, press [ENTER].
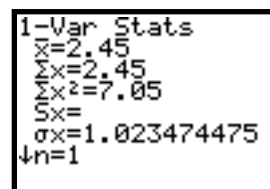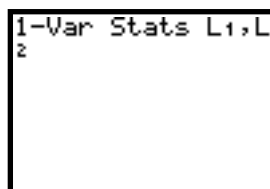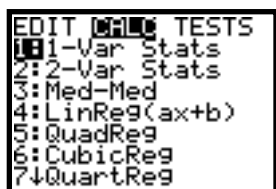
        The expected value (or mean) of the discrete random variable is the value of $\bar{x}$. For our example, the average grade in the large introductory statistics class is 2.45 (or between a B and a C).

II. *Standard Deviation of a Discrete Random Variable*

    1. Be sure that the data has been entered as prescribed in I.1, above. Press [STAT] then press [▶] to get to the CALC menu and select the first option, 1:1-Var Stats. Now enter the name of the list that contains the values of the discrete random value (*e.g.* L1—[2nd][1]) followed by [,] and the name of the list that contains the corresponding probabilities (*e.g.* L2—[2nd][2]). Finally, press [ENTER].
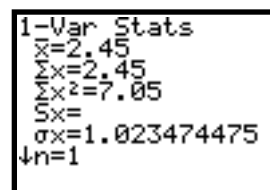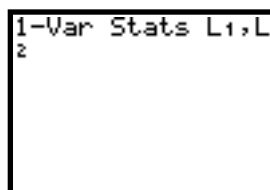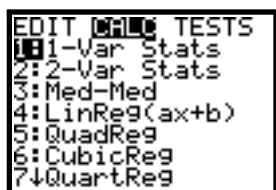
        The standard deviation of the discrete random variable is the value of σx. For our example, the average grade in the large introductory statistics class is 1.023474475.

Binomial Probabilities in the TI-83/84

I. *Factorials*

1. The factorial operation is located at [MATH] [▶][▶][▶] PRB [▼][▼][▼] 4:! (see example, below).

2. For example, 5 factorial is computed as [5] [MATH] [▶][▶][▶] PRB [▼][▼][▼] 4:! [ENTER] (below), then press [ENTER] once more to get the answer (right picture).
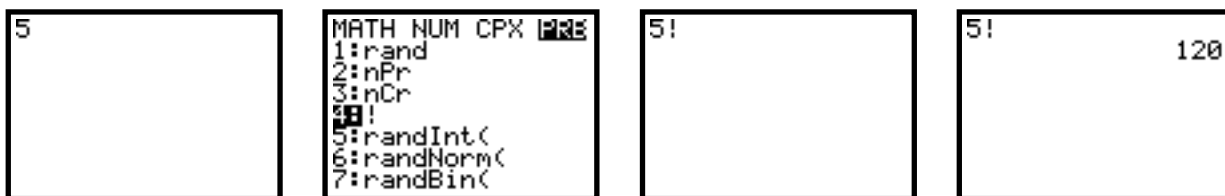
II. *Binomial Coefficients*

1. The binomial coefficient operation is located at [MATH] [▶][▶][▶] PRB [▼][▼] 3:nCr (see below).

2. For example, $\binom{8}{5} = \dfrac{8!}{5!(8-5)!}$ can be computed using the factorials (above) or by the direct method as follows: [8] [MATH] [▶][▶][▶] PRB [▼][▼] 3:nCr [ENTER] [5] (below), then press [ENTER] once more to get the answer (right picture).
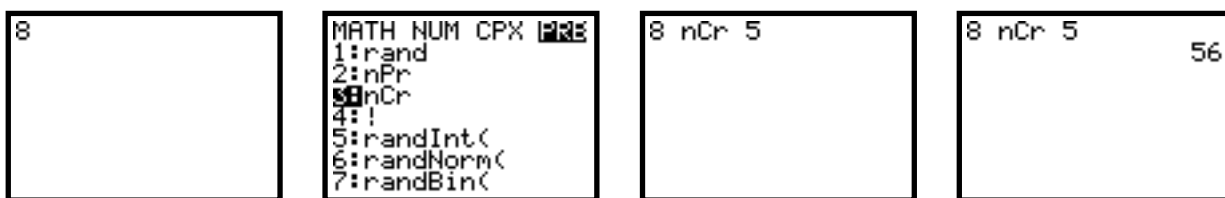
III. *Binomial Probabilities*

1. Binomial probabilities can be computed using the information above with the binomial probability formula, or they can be computed directly with the TI-83. Use [2nd][VARS] [DISTR] scroll down to Ø:binompdf(and press [ENTER], then enter the values for n, p, and x followed by and [ENTER] (see example, below).

2. For example, suppose you are taking a multiple-choice test with 8 questions and 4 choices for each question. If you guess on each question, your guesses would be independent with a probability of 1/4 of guessing correctly on each individual question. To find the probability of guessing 6 of these questions correctly, simply follow the following steps: press [2nd][VARS] [DISTR] scroll down to Ø:binompdf(and press [ENTER] (left & middle screens), then enter [8] [,][1][÷][4][,][6] followed by [)] and [ENTER] (right screen).
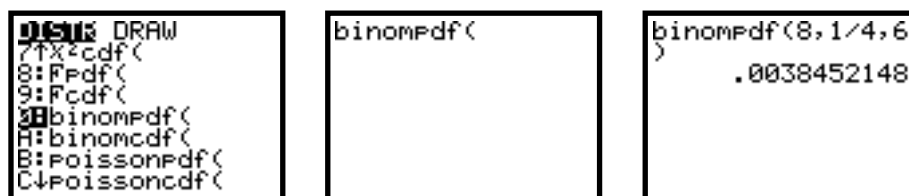
3. To find an entire binomial probability distribution, you must first enter all possible values for *x*, the number of successes, in a list (say L1); these values would be 0, 1, …, *n*. Then you can store the corresponding binomial probabilities in the next list (say L2). To find the binomial probability distribution for our multiple-choice guessing example, enter the values 0, 1, …, 8 into L1 and compute the binomial probabilities for L2 in the following manner: [2nd][VARS] [DISTR] scroll down to Ø:binompdf(and press [ENTER] (left screen); then enter [8] [,] [1] [÷] [4] [,] [2nd][1]   [STO▸] [2nd][2] followed by [ENTER] (middle two screens); the results are seen by viewing your lists (right screen).

IV. *Cumulative Binomial Probabilities*

1. Cumulative binomial probabilities, $P(x \leq c)$, can be computed directly with the TI-83 (thus avoiding the need to use the formula repeatedly and adding the results). Use [2nd][VARS] [DISTR] scroll down to A:binomcdf(and press [ENTER], then enter the values for *n*, *p*, and *c* followed by   and [ENTER] (see example, below).

2. For example, suppose you are taking a multiple-choice test with 8 questions and 4 choices for each question. If you guess on each question, your guesses would be independent with a probability of 1/4 of guessing correctly on each individual question. To find the probability of guessing at most 6 of these questions correctly, $P(x \leq 6) = P(0) + P(1) + P(2) + P(3) + P(4) + P(5) + P(6)$, you can find the individual probabilities or simply follow the following steps: press [2nd][VARS] [DISTR] scroll down to A:binomcdf(and press [ENTER] (left & middle screens), then enter [8] [,] [1] [÷] [4] [,] [6] followed by   and [ENTER] (right screen).

3. To find an entire cumulative binomial probability distribution, you must first enter all possible values for *x*, the number of successes, in a list (say L1); these values would be 0, 1, …, *n*. Then you can store the corresponding binomial probabilities in another list (say L3). For our multiple-choice guessing example, enter the values 0, 1, …, 8 into L1 and compute the cumulative binomial probabilities for L3 in the following manner: [2nd][VARS] [DISTR] scroll down to A:binomcdf(and press [ENTER] (left screen); then enter [8] [,] [1] [÷] [4] [,] [2nd][1]   [STO▸] [2nd][2] followed by [ENTER] (middle two screens); the results can be seen by viewing your lists (right screen).

Inference on Means in the TI-83/84, Part 1

I. *Confidence Intervals (when σ is known, data in one list)*

1. Confidence intervals using the standard normal distribution can be computed using the information in the text with a Standard Normal Table, using the information in the text with `invNorm` (see p. 9 of this document), or they can be computed directly with the TI-83.

   Suppose you are given a list of data. First, enter the values into a list (*e.g.* `L1`). Press `STAT`, scroll over to `TESTS`, scroll down to `7:ZInterval...`, and press `ENTER` (see left image, below). Select `Data` as your input method (`Inpt`), enter the value of sigma (σ), give the list that contains the data (`List`), be sure the frequency (`Freq`) is 1 since all of the data is in one list, and the confidence level (`C-Level`) should be entered as a decimal value (see right image, below). When this is done, move the cursor to `Calculate` and press `ENTER` to view the confidence interval.

2. *Example: Trends in Television*, published by the Television Bureau of Advertising, contains information on the number of television sets owned by U.S. households. Fifty households are selected at random. The number of TV sets per household sampled is as follows.

1	1	1	2	6	3	3	4	2	4
3	2	1	5	2	1	3	6	2	2
3	1	1	4	3	2	2	2	2	3
0	3	1	2	1	2	3	1	1	3
3	2	1	2	1	1	3	1	5	1

   Use the sample data to find a 90% confidence interval for the average number of television sets owned by U.S. households. (Assume that the population standard deviation is 1.25.)

   First, enter the data into a list (*e.g.* `L1`). Press `STAT`, scroll over to `TESTS`, scroll down to `7:ZInterval...`, and press `ENTER` (see second image, below). Select `Data` as your input method, enter the value of sigma (1.25), give the list that contains the data (`L1`), be sure the frequency is 1 since all of the data is in one list, and the confidence level should be entered as a decimal value (0.90). When this is done, move the cursor to `Calculate` and press `ENTER` to view the confidence interval. (Note that the sample mean, sample standard deviation, and sample size are also given, respectively.)

   "We can be 90% confident that the average number of television sets owned by U.S. households is somewhere between 1.9892 and 2.5708 sets."

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II. *Confidence Intervals (when σ is known, data in a frequency distribution table)*

1. Suppose you are given a frequency table of data. First, enter the values into a list (*e.g.* L1), then enter the frequencies into another list (*e.g.* L2). Press STAT, scroll over to TESTS, scroll down to 7:ZInterval..., and press ENTER (see left image, below). Select Data as your input method (Inpt), enter the value of sigma (σ), give the list that contains the data (List), be sure the frequency (Freq) is set to the list that contains the frequencies, and the confidence level (C-Level) should be entered as a decimal value (see right image, below). When done, move cursor to Calculate and press ENTER to view the confidence interval.

2. *Example:* *Trends in Television*, published by the Television Bureau of Advertising, contains information on the number of television sets owned by U.S. households. Fifty households are selected at random. The number of TV sets per household sampled is as follows.
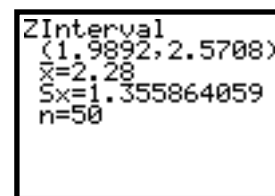
Number of TV Sets	0	1	2	3	4	5	6
Frequency	1	16	14	12	3	2	2

Use the sample data to find a 90% confidence interval for the average number of television sets owned by U.S. households. (Assume that the population standard deviation is 1.25.)

First, enter the data into a list (*e.g.* L1) and the frequencies into another list (*e.g.* L2). Press STAT, scroll over to TESTS, scroll down to 7:ZInterval..., and press ENTER (see second image, below). Select Data as your input method, enter the value of sigma (1.25), give the list that contains the data (L1), enter the list that contains the frequencies (L2), and the confidence level should be entered as a decimal value (0.90). When this is done, move the cursor to Calculate and press ENTER to view the confidence interval. (Note that the sample mean, sample standard deviation, and sample size are also given, respectively.)

"We can be 90% confident that the average number of television sets owned by U.S. households is somewhere between 1.9892 and 2.5708 sets."

III. *Confidence Intervals (when σ is known, summary statistics are given)*

1. Suppose you are given summary statistics for a set of data. First, press $\boxed{\text{STAT}}$, scroll over to TESTS, scroll down to 7:ZInterval..., and press $\boxed{\text{ENTER}}$ (see left image, below). Select Stats as your input method (Inpt), enter the value of sigma (σ), give the sample mean ($\bar{x}$), be sure the sample size (n) is entered, and the confidence level (C-Level) should be entered as a decimal value (see right image, below). When this is done, move the cursor to Calculate and press $\boxed{\text{ENTER}}$ to view the confidence interval.

```
EDIT CALC TESTS          ZInterval
1:Z-Test…                 Inpt:Data Stats
2:T-Test…                 σ:1
3:2-SampZTest…            x:12.5
4:2-SampTTest…            n:287
5:1-PropZTest…            C-Level:.95
6:2-PropZTest…            Calculate
7↓ZInterval…
```
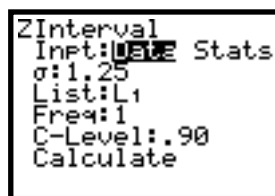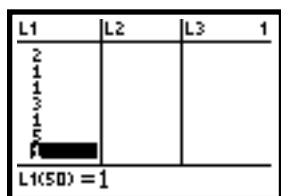
2. *Example: Trends in Television*, published by the Television Bureau of Advertising, contains information on the number of television sets owned by U.S. households. Fifty households are selected at random. Find a 90% confidence interval for the average number of television sets owned by U.S. households. (Note that $\sum x = 114$ and $\sigma = 1.25$.)
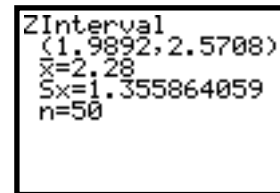
   First, press $\boxed{\text{STAT}}$, scroll over to TESTS, scroll down to 7:ZInterval..., and press $\boxed{\text{ENTER}}$ (see left image, below). Select Stats as your input method, enter the value of sigma (1.25), give the sample mean (114 / 50), be sure the sample size is entered (50), and the confidence level should be entered as a decimal value (0.90). When this is done, move the cursor to Calculate and press $\boxed{\text{ENTER}}$ to view the confidence interval. (Note that the user-entered values of the sample mean and sample size are also displayed, respectively.)

```
ZInterval                ZInterval
 Inpt:Data Stats         (1.9892,2.5708)
 σ:1.25                  x̄=2.28
 x:114/50                n=50
 n:50
 C-Level:.9
 Calculate
```

   "We can be 90% confident that the average number of television sets owned by U.S. households is somewhere between 1.9892 and 2.5708 sets."

IV. *Hypothesis Tests for μ (when σ is known, data in one list)*

1. Hypothesis tests using the standard normal distribution can be computed using the information in the text with a Standard Normal Table, using the information in the text with `invNorm` (see p. 9 of this document), or they can be computed directly with the TI-83.

    Suppose you are given a list of data. First, enter the values into a list (*e.g.* `L1`). Press STAT, scroll over to `TESTS`, scroll down to `1:Z-Test...`, and press ENTER (see left image, below). Select `Data` as your input method (`Inpt`), enter the value of hypothesized mean (μ_0), enter the value of sigma (σ), give the list that contains the data (`List`), be sure the frequency (`Freq`) is 1 since all of the data is in one list, and select the appropriate alternative hypothesis (μ:) (see right image, below). When this is done, move the cursor to `Calculate` and press ENTER to view the results.
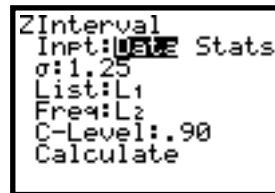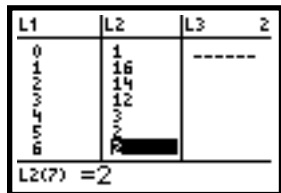

2. *Example:* The 1998 issue of *Trends in Television*, published by the Television Bureau of Advertising, contains information on the number of television sets owned by U.S. households. Fifty households are selected at random. The number of TV sets per household sampled is as follows.

1	1	1	2	6	3	3	4	2	4
3	2	1	5	2	1	3	6	2	2
3	1	1	4	3	2	2	2	2	3
0	3	1	2	1	2	3	1	1	3
3	2	1	2	1	1	3	1	5	1

    In 1980, the average number of television sets owned by U.S. households was 1.75 sets. At the 5% significance level, has the average number of television sets owned by U.S. households increased since 1980? (Assume that the population standard deviation is 1.25.)

    First, enter the data into a list (*e.g.* `L1`). Press STAT, scroll over to `TESTS`, scroll down to `1:Z-Test...`, and press ENTER (see second image, below). Select `Data` as your input method, enter the value of the hypothesized mean (1.75), enter the value of sigma (1.25), give the list that contains the data (`L1`), be sure the frequency is 1 since all of the data is in one list, and the appropriate alternative hypothesis should be selected (>μ_0). When this is done, move the cursor to `Calculate` and press ENTER to view the results. (Note that the alternative hypothesis, test statistic value, *p*–value, sample mean, sample standard deviation, and sample size are given, respectively.)

    Now you must present your hypothesis test analysis, incorporating your TI-83 results.

V. *Hypothesis Tests for μ (when σ is known, data in a frequency distribution table)*

1. Suppose you are given a frequency table of data. First, enter the values into a list (*e.g.* L1), then enter the frequencies into another list (*e.g.* L2). Press $\boxed{\text{STAT}}$, scroll over to TESTS, scroll down to 1:Z-Test…, and press $\boxed{\text{ENTER}}$ (see left image, below). Select Data as your input method (Inpt), enter the value of hypothesized mean (μ_0), enter the value of sigma (σ), give the list that contains the data (List), be sure the frequency (Freq) is set to the list that contains the frequencies, and select the appropriate alternative hypothesis (μ:) (see right image, below). When this is done, move the cursor to Calculate and press $\boxed{\text{ENTER}}$ to view the results.
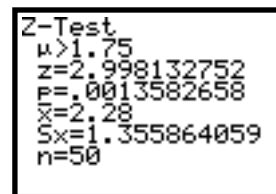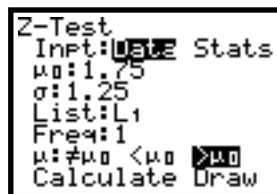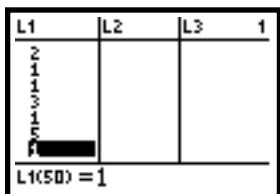
2. *Example:* The 1998 issue of *Trends in Television*, published by the Television Bureau of Advertising, contains information on the number of television sets owned by U.S. households. Fifty households are selected at random. The number of TV sets per household sampled is as follows.

Number of TV Sets	0	1	2	3	4	5	6
Frequency	1	16	14	12	3	2	2

In 1980, the average number of television sets owned by U.S. households was 1.75 sets. At the 5% significance level, has the average number of television sets owned by U.S. households increased since 1980? (Assume that the population standard deviation is 1.25.)

First, enter the data into a list (*e.g.* L1) and the frequencies into another list (*e.g.* L2). Press $\boxed{\text{STAT}}$, scroll over to TESTS, scroll down to 1:Z-Test…, and press $\boxed{\text{ENTER}}$ (see second image, below). Select Data as your input method, enter the value of the hypothesized mean (1.75), enter the value of sigma (1.25), give the list that contains the data (L1), enter the list that contains the frequencies (L2), and the appropriate alternative hypothesis should be selected ($>\mu_0$). When this is done, move the cursor to Calculate and press $\boxed{\text{ENTER}}$ to view the results. (Note that the alternative hypothesis, test statistic value, *p*-value, sample mean, sample standard deviation, and sample size are given, respectively.)

Now you must present your hypothesis test analysis, incorporating your TI-83 results.

VI. *Hypothesis Tests for μ (when σ is known, summary statistics are given)*

1. Suppose you are given summary statistics for a set of data. First, press $\boxed{\text{STAT}}$, scroll over to TESTS, scroll down to 1:Z-Test…, and press $\boxed{\text{ENTER}}$ (see left image, below). Select Stats as your input method (Inpt), enter the value of hypothesized mean (μ_0), enter the value of sigma (σ), give the sample mean ($\bar{x}$), be sure the sample size (n) is entered, and select the appropriate alternative hypothesis (μ:) (see right image, below). When this is done, move the cursor to Calculate and press $\boxed{\text{ENTER}}$ to view the results.

```
EDIT CALC TESTS
1◼Z-Test…
2:T-Test…
3:2-SampZTest…
4:2-SampTTest…
5:1-PropZTest…
6:2-PropZTest…
7↓ZInterval…
```
```
Z-Test
 Inpt:Data Stats
 μ0:0
 σ:1
 x̄:.1
 n:50
 μ:≠μ0 <μ0 >μ0
Calculate Draw
```

2. *Example:* The 1998 issue of *Trends in Television*, published by the Television Bureau of Advertising, contains information on the number of television sets owned by U.S. households. Fifty households are selected at random. In 1980, the average number of television sets owned by U.S. households was 1.75 sets. At the 5% significance level, has the average number of television sets owned by U.S. households increased since 1980? (Note that $\sum x = 114$ and $\sigma = 1.25$.)
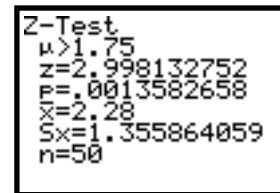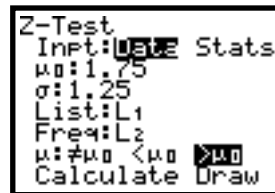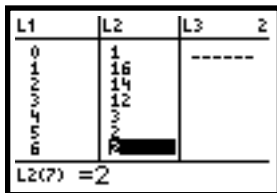
First, press $\boxed{\text{STAT}}$, scroll over to TESTS, scroll down to 1:Z-Test…, and press $\boxed{\text{ENTER}}$ (see left image, below). Select Stats as your input method, enter the value of the hypothesized mean (1.75), enter the value of sigma (1.25), give the sample mean (114 / 50), be sure the sample size is entered (50), and the appropriate alternative hypothesis should be selected (>μ_0). When this is done, move the cursor to Calculate and press $\boxed{\text{ENTER}}$ to view the results. (Note that the alternative hypothesis, test statistic value, *p*-value, user-entered sample mean, and user-entered sample size are given, respectively.)

```
Z-Test
 Inpt:Data Stats
 μ0:1.75
 σ:1.25
 x̄:114/50
 n:50
 μ:≠μ0 <μ0 >μ0
Calculate Draw
```
```
Z-Test
 μ>1.75
 z=2.998132752
 p=.0013582658
 x̄=2.28
 n=50
```

Now you must present your hypothesis test analysis, incorporating your TI-83 results.

Inference on Means in the TI-83/84, Part 2

I. *Confidence Intervals (normal population when σ is not known, data in one list)*

1. Confidence intervals using the student's *t*-distribution can be computed using the information in the text with a Student's T-Distribution Table, or they can be computed directly with the TI-83.

    Suppose you are given a list of data. First, enter the values into a list (*e.g.* L1). Press [STAT], scroll over to TESTS, scroll down to 8:TInterval…, and press [ENTER] (see left image, below). Select Data as your input method (Inpt), give the list that contains the data (List), be sure the frequency (Freq) is 1 since all of the data is in one list, and the confidence level (C-Level) should be entered as a decimal value (see right image, below). When done, move cursor to Calculate and press [ENTER] to view the confidence interval.

2. *Example:* An English professor wants to estimate the average study time per week for students in introductory English courses at her school. To accomplish that, she randomly selects 25 students and records their weekly study times. The times, in hours, follow.

9	8	7	6	7
8	9	4	7	6
6	4	11	5	4
3	7	8	8	7
6	2	2	8	6

    Use the sample data to find a 95% confidence interval for the mean weekly study time of introductory English students at the school. (Assume that the weekly study times are normally distributed.)

    First, enter the data into a list (*e.g.* L1). Press [STAT], scroll over to TESTS, scroll down to 8:TInterval…, and press [ENTER] (see second image, below). Select Data as your input method, give the list that contains the data (L1), be sure the frequency is 1 since all of the data is in one list, and the confidence level should be entered as a decimal value (0.95). When this is done, move the cursor to Calculate and press [ENTER] to view the confidence interval. (Note that the sample mean, sample standard deviation, and sample size are also given, respectively.)

    "We can be 95% confident that the mean weekly study time of introductory English students at the school is somewhere between 5.3992 hours and 7.2408 hours."

II. *Confidence Intervals (normal pop. when σ is not known, data in a frequency distribution table)*

1. Suppose you are given a frequency table of data. First, enter the values into a list (*e.g.* L1), then enter the frequencies into another list (*e.g.* L2). Press $\boxed{\text{STAT}}$, scroll over to TESTS, scroll down to 8:TInterval…, and press $\boxed{\text{ENTER}}$ (see left image, below). Select Data as your input method (Inpt), give the list that contains the data (List), be sure the frequency (Freq) is set to the list that contains the frequencies, and the confidence level (C-Level) should be entered as a decimal value (see right image, below). When this is done, move the cursor to Calculate and press $\boxed{\text{ENTER}}$ to view the confidence interval.
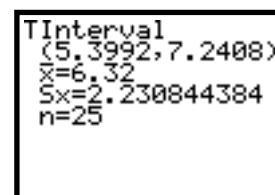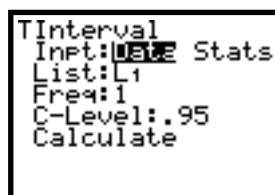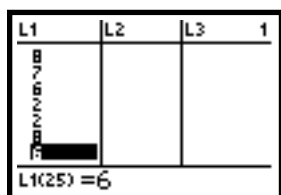

2. *Example:* An English professor wants to estimate the average study time per week for students in introductory English courses at her school. To accomplish that, she randomly selects 25 students and records their weekly study times. The times, in hours, follow.

Number of Study Hours	2	3	4	5	6	7	8	9	10	11
Frequency	2	1	3	1	5	5	5	2	0	1

Use the sample data to find a 95% confidence interval for the mean weekly study time of introductory English students at the school. (Assume that the weekly study times are normally distributed.)

First, enter the data into a list (*e.g.* L1) and the frequencies into another list (*e.g.* L2). Press $\boxed{\text{STAT}}$, scroll over to TESTS, scroll down to 8:TInterval…, and press $\boxed{\text{ENTER}}$ (see second image, below). Select Data as your input method, give the list that contains the data (L1), enter the list that contains the frequencies (L2), and the confidence level should be entered as a decimal value (0.95). When this is done, move the cursor to Calculate and press $\boxed{\text{ENTER}}$ to view the confidence interval. (Note that the sample mean, sample standard deviation, and sample size are also given, respectively.)

"We can be 95% confident that the mean weekly study time of introductory English students at the school is somewhere between 5.3992 hours and 7.2408 hours."

III. *Confidence Intervals (normal population when σ is not known, summary statistics are given)*

1. Suppose you are given summary statistics for a set of data. First, press $\boxed{\text{STAT}}$, scroll over to TESTS, scroll down to 8:TInterval…, and press $\boxed{\text{ENTER}}$ (see left image, below). Select Stats as your input method (Inpt), give the sample mean ($\bar{x}$), give the sample standard deviation (Sx), be sure the sample size (n) is entered, and the confidence level (C-Level) should be entered as a decimal value (see right image, below). When this is done, move the cursor to Calculate and press $\boxed{\text{ENTER}}$ to view the confidence interval.

```
EDIT CALC TESTS
2↑T-Test…
3:2-SampZTest…
4:2-SampTTest…
5:1-PropZTest…
6:2-PropZTest…
7:ZInterval…
8↓TInterval…
```

```
TInterval
 Inpt:Data Stats
 x:12.5
 Sx:1.25
 n:18
 C-Level:.95
 Calculate
```

2. *Example:* An English professor wants to estimate the average study time per week for students in introductory English courses at her school. To accomplish that, she randomly selects 25 students and records their weekly study times. Find a 95% confidence interval for the mean weekly study time of introductory English students at the school. (Note that the weekly study times are normally distributed with $\bar{x} = 6.32$ and $s = 2.2308$.)
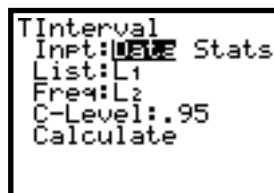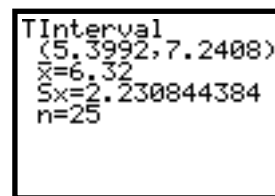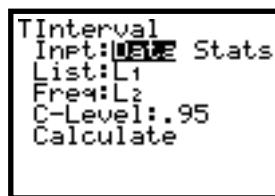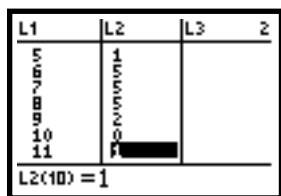
First, press $\boxed{\text{STAT}}$, scroll over to TESTS, scroll down to 8:TInterval…, and press $\boxed{\text{ENTER}}$ (see left image, below). Select Stats as your input method, give the sample mean (6.32), give the sample standard deviation (2.2308), be sure the sample size is entered (25), and the confidence level should be entered as a decimal value (0.95). When this is done, move the cursor to Calculate and press $\boxed{\text{ENTER}}$ to view the confidence interval. (Note that the user-entered values for the sample mean, sample standard deviation, and sample size are also displayed, respectively.)

```
TInterval
 Inpt:Data Stats
 x:6.32
 Sx:2.2308
 n:25
 C-Level:.95
 Calculate
```

```
TInterval
 (5.3992,7.2408)
 x=6.32
 Sx=2.2308
 n=25
```

"We can be 95% confident that the mean weekly study time of introductory English students at the school is somewhere between 5.3992 hours and 7.2408 hours."

IV. *Hypothesis Tests for μ (normal population when σ is not known, data in one list)*

1. Hypothesis tests using the student's *t*-distribution can be computed using the information in the text with a Student's T-Distribution Table, or they can be computed directly with the TI-83.

   Suppose you are given a list of data. First, enter the values into a list (*e.g.* L1). Press $\boxed{\text{STAT}}$, scroll over to TESTS, scroll down to 2:T-Test…, and press $\boxed{\text{ENTER}}$ (see left image, below). Select Data as your input method (Inpt), enter the value of hypothesized mean (μ_0), give the list that contains the data (List), be sure the frequency (Freq) is 1 since all of the data is in one list, and select the appropriate alternative hypothesis (μ:) (see right image, below). When this is done, move the cursor to Calculate and press $\boxed{\text{ENTER}}$ to view the results.

2. *Example:* An English professor wants to estimate the average study time per week for students in introductory English courses at her school. To accomplish that, she randomly selects 25 students and records their weekly study times. The times, in hours, follow.

9	8	7	6	7
8	9	4	7	6
6	4	11	5	4
3	7	8	8	7
6	2	2	8	6

   Use the sample data to determine if the mean weekly study time of introductory English students at the school differs from the 5.75 hours spent on average at a neighboring school. (Assume that the weekly study times are normally distributed.)

   First, enter the data into a list (*e.g.* L1). Press $\boxed{\text{STAT}}$, scroll over to TESTS, scroll down to 2:T-Test…, and press $\boxed{\text{ENTER}}$ (see second image, below). Select Data as your input method, enter the value of the hypothesized mean (5.75), give the list that contains the data (L1), be sure the frequency is 1 since all of the data is in one list, and the appropriate alternative hypothesis should be selected ($\neq\mu_0$). When this is done, move the cursor to Calculate and press $\boxed{\text{ENTER}}$ to view the results. (Note that the alternative hypothesis, test statistic value, *p*-value, sample mean, sample standard deviation, and sample size are given, respectively.)

   Now you must present your hypothesis test analysis, incorporating your TI-83 results.

V. *Hypothesis Tests for μ (normal pop. when σ is not known, data in a frequency distribution table)*

1. Suppose you are given a frequency table of data. First, enter the values into a list (*e.g.* L1), then enter the frequencies into another list (*e.g.* L2). Press STAT, scroll over to TESTS, scroll down to 2:T-Test…, and press ENTER (see left image, below). Select Data as your input method (Inpt), enter the value of hypothesized mean (μ_0), give the list that contains the data (List), be sure the frequency (Freq) is set to the list that contains the frequencies, and select the appropriate alternative hypothesis (μ:) (see right image, below). When this is done, move the cursor to Calculate and press ENTER to view the results.

```
EDIT CALC TESTS
1:Z-Test…
2:T-Test…
3:2-SampZTest…
4:2-SampTTest…
5:1-PropZTest…
6:2-PropZTest…
7↓ZInterval…
```
```
T-Test
Inpt:Data Stats
μ0:0
List:L1
Freq:L2
μ:≠μ0  <μ0  >μ0
Calculate Draw
```
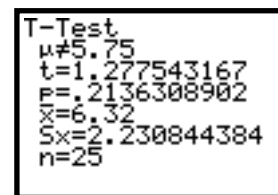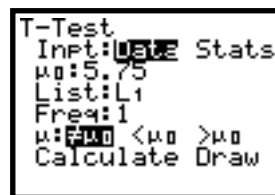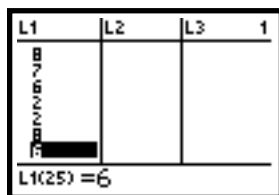
2. *Example:* An English professor wants to estimate the average study time per week for students in introductory English courses at her school. To accomplish that, she randomly selects 25 students and records their weekly study times. The times, in hours, follow.

Number of Study Hours	2	3	4	5	6	7	8	9	10	11
Frequency	2	1	3	1	5	5	5	2	0	1

Use the sample data to determine if the mean weekly study time of introductory English students at the school differs from the 5.75 hours spent on average at a neighboring school. (Assume that the weekly study times are normally distributed.)
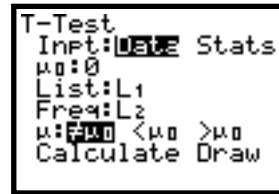
First, enter the data into a list (*e.g.* L1) and the frequencies into another list (*e.g.* L2). Press STAT, scroll over to TESTS, scroll down to 2:T-Test…, and press ENTER (see second image, below). Select Data as your input method, enter the value of the hypothesized mean (5.75), give the list that contains the data (L1), enter the list that contains the frequencies (L2), and the appropriate alternative hypothesis should be selected ($\neq\mu_0$). When this is done, move the cursor to Calculate and press ENTER to view the results. (Note that the alternative hypothesis, test statistic value, *p*–value, sample mean, sample standard deviation, and sample size are given, respectively.)

```
L1    L2    L3    2
5     1
6     5
7     5
8     2
9
10    0
11    1
L2(10)=1
```
```
T-Test
Inpt:Data Stats
μ0:5.75
List:L1
Freq:L2
μ:≠μ0  <μ0  >μ0
Calculate Draw
```
```
T-Test
μ≠5.75
t=1.277543167
p=.2136308902
x̄=6.32
Sx=2.230844384
n=25
```

Now you must present your hypothesis test analysis, incorporating your TI-83 results.

VI. *Hypothesis Tests for μ (normal population when σ is not known, summary statistics are given)*

1. Suppose you are given summary statistics for a set of data. First, press STAT, scroll over to TESTS, scroll down to 2:T-Test…, and press ENTER (see left image, below). Select Stats as your input method (Inpt), enter the value of hypothesized mean (μ_0), give the sample mean ($\bar{x}$), give the sample standard deviation (Sx), be sure the sample size (n) is entered, and select the appropriate alternative hypothesis (μ:) (see right image, below). When this is done, move the cursor to Calculate and press ENTER to view the results.

```
EDIT CALC TESTS
1:Z-Test…
2↑T-Test…
3:2-SampZTest…
4:2-SampTTest…
5:1-PropZTest…
6:2-PropZTest…
7↓ZInterval…
```

```
T-Test
 Inpt:Data Stats
 μ0:0
 x̄:.1
 Sx:.25
 n:20
 μ:≠μ0  <μ0  >μ0
 Calculate Draw
```
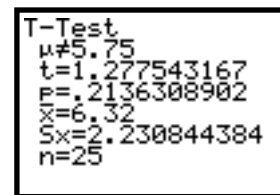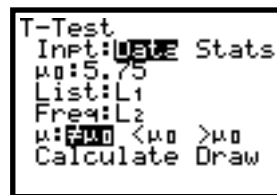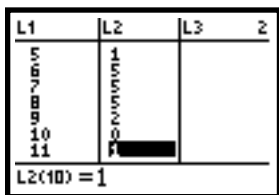
2. *Example:* An English professor wants to estimate the average study time per week for students in introductory English courses at her school. To accomplish that, she randomly selects 25 students and records their weekly study times. Determine if the mean weekly study time of introductory English students at the school differs from the 5.75 hours spent on average at a neighboring school. (Note that the weekly study times at the English professor's school are normally distributed with $\bar{x} = 6.32$ and $s = 2.2308$.)
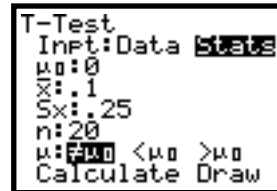
First, press STAT, scroll over to TESTS, scroll down to 2:T-Test…, and press ENTER (see left image, below). Select Stats as your input method, enter the value of the hypothesized mean (5.75), give the sample mean (6.32), enter the sample standard deviation (2.2308), be sure the sample size is entered (25), and the appropriate alternative hypothesis should be selected ($\neq\mu_0$).

When this is done, move the cursor to Calculate and press ENTER to view the results. (Note that the alternative hypothesis, test statistic value, *p*-value, user-entered sample mean, user-entered sample standard deviation, and user-entered sample size are given, respectively.)
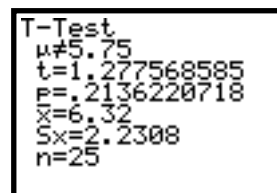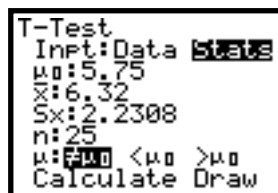
```
T-Test
 Inpt:Data Stats
 μ0:5.75
 x̄:6.32
 Sx:2.2308
 n:25
 μ:≠μ0  <μ0  >μ0
 Calculate Draw
```

```
T-Test
 μ≠5.75
 t=1.277568585
 p=.2136220718
 x̄=6.32
 Sx=2.2308
 n=25
```

Now you must present your hypothesis test analysis, incorporating your TI-83 results.

Inference on Means in the TI-83/84, Part 3

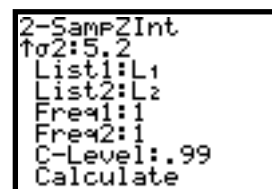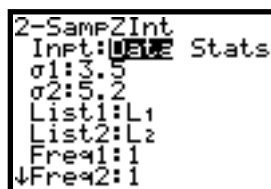I. *Confidence Intervals for the diff. in pop. means, $\mu_1 - \mu_2$ [σ_1 & σ_2 known (or $n_1 \geq 30$ & $n_1 \geq 30$)]*

    1. Suppose you are given two lists of data. First, enter the values into two lists (*e.g.* L1, L2). Press STAT, scroll over to TESTS, scroll down to 9:2-SampZInt..., and press ENTER (see left image, below). Select Data as your input method (Inpt) [Stats is used when summary statistics are given], enter the values of sigma-1 and sigma-2 (σ_1 & σ_2), give the lists that contain the data (List1 & List2), be sure the frequencies (Freq1 & Freq2) are 1 since all of the data from each sample is in one list (otherwise give the list that contains the frequencies for each sample), and the confidence level (C-Level) should be entered as a decimal value (see right images, below). When this is done, move the cursor to Calculate and press ENTER to view the confidence interval.

    2. *Example:* The U.S. Department of Agriculture compiles information on acreage, production, and value of potatoes and publishes its findings in *Agricultural Statistics*. The yield of potatoes is measured in hundreds of pounds (cwt.) per acre. A random sample of forty 1–acre plots of potatoes is taken from Idaho, and a random sample of thirty-two 1–acre plots of potatoes is taken from Nevada. The yields of the plots sampled are displayed in the following table.

Idaho					Nevada			
229	267	326	309	231	283	254	328	292
283	344	310	258	316	315	336	378	314
241	281	218	284	311	312	328	272	307
254	217	267	299	266	348	233	354	400
264	264	290	312	298	341	313	309	308
305	244	303	299	285	340	300	316	268
308	260	204	291	242	259	276	271	362
329	315	246	322	293	340	339	300	333

Find a 90% confidence interval for the difference between the mean yields per acre of potatoes for Idaho and Nevada. (Assume that the population standard deviations are 34.6 cwt. and 37.2 cwt., respectively.)

First, enter the data into two lists (*e.g.* L1, L2). Press STAT, scroll over to TESTS, scroll down to 9:2-SampZInt..., and press ENTER (see second image, below). Select Data as your input method, enter the value of sigma-1 (34.6) and sigma-2 (37.2), give the lists that contains the data (L1, L2), be sure the frequencies are 1, and the confidence level should be entered as a decimal value (0.90). When this is done, move the cursor to Calculate and press ENTER to view the confidence interval.
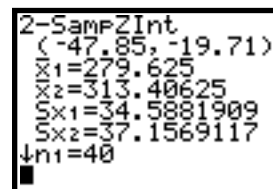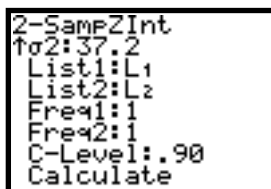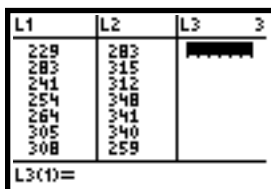
"We can be 90% confident that the difference, $\mu_1 - \mu_2$, between the average yields per acre of potatoes for Idaho and Nevada is somewhere between -47.85 cwt. and -19.71 cwt."

II. *Confidence Intervals for the diff. in means, $\mu_1 - \mu_2$ [normal pops. when $\sigma_1 = \sigma_2$ but unknown]*

1. Suppose you are given two lists of data. First, enter the values into two lists (*e.g.* L1, L2). Press [STAT], scroll over to TESTS, scroll down to Ø:2-SampTInt…, and press [ENTER] (see left image, below). Select Data as your input method (Inpt) [Stats is used when summary statistics are given], give the lists that contain the data (List1 & List2), be sure the frequencies (Freq1 & Freq2) are 1 since all of the data from each sample is in one list (otherwise give the list that contains the frequencies for each sample), the confidence level (C-Level) should be entered as a decimal value, and Pooled should be Yes since we think the unknown population standard deviations are probably equal (see right images, below). When this is done, move the cursor to Calculate and press [ENTER] to view the confidence interval. (Note that the degrees of freedom, sample means, sample standard deviations, pooled standard deviation, and sample sizes are displayed, respectively.)

2. *Example:* In a packing plant, a machine packs cartons with jars. A salesperson claims that the machine she is selling will pack faster with the same accuracy (variability) as the present machine. To test that claim, the times it takes each machine to pack ten cartons are recorded. The results, in seconds, are shown in the following table.

New Machine		Present Machine	
42.0	41.0	42.7	43.6
41.3	41.8	43.8	43.3
42.4	42.8	42.5	43.5
43.2	42.3	43.1	41.7
41.8	42.7	44.0	44.1

Determine a 95% confidence interval for the difference, $\mu_1 - \mu_2$, between the mean time it takes the new machine to pack ten cartons and the mean time it takes the present machine to pack ten cartons. (Preliminary analyses indicate that the data come from normally distributed populations.)

First, enter the data into two lists (*e.g.* L1, L2). Press [STAT], scroll over to TESTS, scroll down to Ø:2-SampTInt…, and press [ENTER] (see second image, below). Select Data as your input method, give the lists that contains the data (L1, L2), be sure the frequencies are 1, the confidence level should be entered as a decimal value (0.95), and Pooled should be Yes since we think the unknown population standard deviations (measures of variability) are probably equal. When this is done, move the cursor to Calculate and press [ENTER] to view the confidence interval.
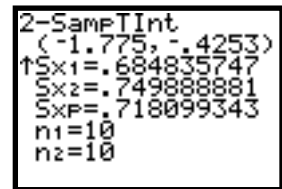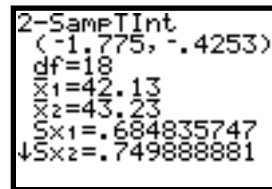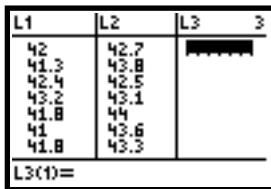
"We can be 90% confident that the difference, $\mu_1 - \mu_2$, between the average packing times of the two machines is somewhere between -1.775 and -0.4253 seconds."

III. *Confidence Intervals for the diff. in means, $\mu_1 - \mu_2$ [normal pops. when $\sigma_1 \neq \sigma_2$ but unknown]*

    1. Suppose you are given two lists of data. First, enter the values into two lists (*e.g.* L1, L2). Press STAT, scroll over to TESTS, scroll down to Ø:2-SampTInt…, and press ENTER (see left image, below). Select Data as your input method (Inpt) [Stats is used when summary statistics are given], give the lists that contain the data (List1 & List2), be sure the frequencies (Freq1 & Freq2) are 1 since all of the data from each sample is in one list (otherwise give the list that contains the frequencies for each sample), the confidence level (C-Level) should be entered as a decimal value, and Pooled should be No since we think the unknown population standard deviations are not equal (see right images, below). When this is done, move the cursor to Calculate and press ENTER to view the confidence interval. (Note that the degrees of freedom, sample means, sample standard deviations, and sample sizes are displayed, respectively.)


    2. *Example:* The U.S. Bureau of Labor Statistics conducts monthly surveys to estimate hourly earnings of nonsupervisory employees in various industry groups. Results of the surveys can be found in *Employment and Earnings*. Independent random samples of 14 mine workers and 17 construction workers yield the following statistics.

Mining	Construction
$\bar{x}_1 = \$13.93$	$\bar{x}_2 = \$14.42$
$s_1 = \$2.25$	$s_2 = \$2.36$

Determine a 90% confidence interval for the difference, $\mu_1 - \mu_2$, between the mean hourly earnings of mine workers and the mean hourly earnings of construction workers.

Since we have summary statistics, we need not enter any data. Press STAT, scroll over to TESTS, scroll down to Ø:2-SampTInt…, and press ENTER (see left images, below). Select Stats as your input method, enter for each sample the values of: mean, standard deviation, and sample size, the confidence level should be entered as a decimal value (0.95), and Pooled should be No since we think the unknown population standard deviations (measures of variability) are not equal. When this is done, move the cursor to Calculate and press ENTER to view the confidence interval.
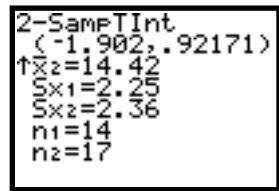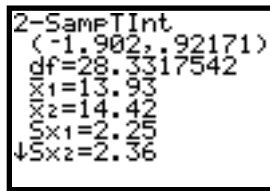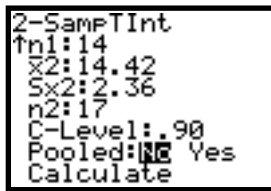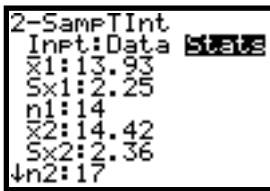
"We can be 90% confident that the difference, $\mu_1 - \mu_2$, between the average hourly earnings of mine workers and the average hourly earnings of construction workers is somewhere between –$1.902 and –$0.92171."

IV. *Hypothesis Tests for the equality of pop. means, $\mu_1 = \mu_2$ [σ_1 & σ_2 known (or $n_1 \geq 30$ & $n_1 \geq 30$)]*
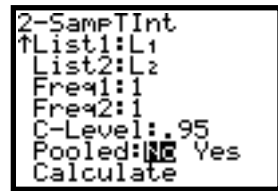
1. Suppose you are given two lists of data. First, enter the values into two lists (*e.g.* L1, L2). Press STAT, scroll over to TESTS, scroll down to 3:2-SampZTest…, and press ENTER (see left image, below). Select Data as your input method (Inpt) [Stats is used when summary statistics are given], enter the values of sigma-1 and sigma-2 (σ_1 & σ_2), give the lists that contain the data (List1 & List2), be sure the frequencies (Freq1 & Freq2) are 1 since all of the data from each sample is in one list (otherwise give the list that contains the frequencies for each sample), and select the appropriate alternative hypothesis (μ_1:) (see right image, below). When this is done, move the cursor to Calculate and press ENTER to view the results.

```
EDIT CALC TESTS       2-SampZTest           2-SampZTest
1:Z-Test…              Inpt:DATA Stats       ↑σ2:.479
2:T-Test…              σ1:.541               List1:L₁
3:2-SampZTest…         σ2:.479               List2:L₂
4:2-SampTTest…         List1:L₁              Freq1:1
5:1-PropZTest…         List2:L₂              Freq2:1
6:2-PropZTest…         Freq1:1               μ1:≠μ2 <μ2 >μ2
7↓ZInterval…           ↓Freq2:1              Calculate Draw
```
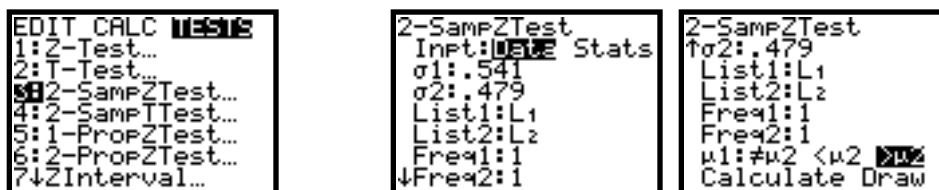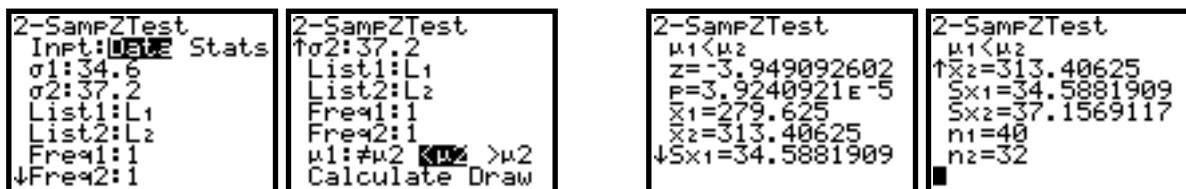
2. *Example:* The U.S. Department of Agriculture compiles information on acreage, production, and value of potatoes and publishes its findings in *Agricultural Statistics*. The yield of potatoes is measured in hundreds of pounds (cwt.) per acre. A random sample of forty 1–acre plots of potatoes is taken from Idaho, and a random sample of thirty-two 1–acre plots of potatoes is taken from Nevada. The yields of the plots sampled are displayed in the following table.

Idaho					Nevada			
229	267	326	309	231	283	254	328	292
283	344	310	258	316	315	336	378	314
241	281	218	284	311	312	328	272	307
254	217	267	299	266	348	233	354	400
264	264	290	312	298	341	313	309	308
305	244	303	299	285	340	300	316	268
308	260	204	291	242	259	276	271	362
329	315	246	322	293	340	339	300	333

At the 5% significance level, is there significant evidence that the mean yields per acre of potatoes for Idaho less than that for Nevada? (Assume that the population standard deviations are 34.6 cwt. and 37.2 cwt., respectively.)

First, enter the data into two lists (*e.g.* L1, L2). Press STAT, scroll over to TESTS, scroll down to 3:2-SampZTest…, and press ENTER (see left images, below). Select Data as your input method, enter the value of sigma-1 (34.6) and sigma-2 (37.2), give the lists that contains the data (L1, L2), be sure the frequencies are 1, and select the appropriate alternative hypothesis (<μ_2). When this is done, move the cursor to Calculate and press ENTER to view the results (see right images, below).

```
2-SampZTest       2-SampZTest       2-SampZTest           2-SampZTest
Inpt:DATA Stats   ↑σ2:37.2          μ1<μ2                 μ1<μ2
σ1:34.6           List1:L₁          z=-3.949092602        ↑x̄2=313.40625
σ2:37.2           List2:L₂          p=3.9240921ε-5        Sx1=34.5881909
List1:L₁          Freq1:1           x̄1=279.625            Sx2=37.1569117
List2:L₂          Freq2:1           x̄2=313.40625          n1=40
Freq1:1           μ1:≠μ2 <μ2 >μ2    ↓Sx1=34.5881909       n2=32
↓Freq2:1          Calculate Draw
```

Now you must present your hypothesis test analysis, incorporating your TI-83 results.

V. *Hypothesis Tests for the equality of means, $\mu_1 = \mu_2$ [normal pops. when $\sigma_1 = \sigma_2$ but unknown]*

1. Suppose you are given two lists of data. First, enter the values into two lists (*e.g.* L1, L2). Press $\boxed{\text{STAT}}$, scroll over to TESTS, scroll down to 4:2-SampTTest..., and press $\boxed{\text{ENTER}}$ (see left image, below). Select Data as your input method (Inpt) [Stats is used when summary statistics are given], give the lists that contain the data (List1 & List2), be sure the frequencies (Freq1 & Freq2) are 1 since all of the data from each sample is in one list (otherwise give the list that contains the frequencies for each sample), select the appropriate alternative hypothesis ($\mu1$:), and Pooled should be Yes since we think the unknown population standard deviations are probably equal (see right images, below). When this is done, move the cursor to Calculate and press $\boxed{\text{ENTER}}$ to view the results. (Note that the degrees of freedom, sample means, sample standard deviations, pooled standard deviation, and sample sizes are displayed, respectively.)

2. *Example:* In a packing plant, a machine packs cartons with jars. A salesperson claims that the machine she is selling will pack faster with the same accuracy (variability) as the present machine. To test that claim, the times it takes each machine to pack ten cartons are recorded. The results, in seconds, are shown in the following table.

New Machine		Present Machine	
42.0	41.0	42.7	43.6
41.3	41.8	43.8	43.3
42.4	42.8	42.5	43.5
43.2	42.3	43.1	41.7
41.8	42.7	44.0	44.1

At the 5% significance level, is the mean time it takes the new machine to pack ten cartons faster than the mean time it takes the present machine to pack ten cartons? (Preliminary analyses indicate that the data come from normally distributed populations.)

First, enter the data into two lists (*e.g.* L1, L2). Press $\boxed{\text{STAT}}$, scroll over to TESTS, scroll down to 4:2-SampTTest..., and press $\boxed{\text{ENTER}}$ (see left images, below). Select Data as your input method, give the lists that contains the data (L1, L2), be sure the frequencies are 1, select the appropriate alternative hypothesis (<$\mu2$), and Pooled should be Yes since we think the unknown population standard deviations (measures of variability) are probably equal. When this is done, move the cursor to Calculate and press $\boxed{\text{ENTER}}$ to view the results (see right images, below).

Now you must present your hypothesis test analysis, incorporating your TI-83 results.

VI. *Hypothesis Tests for the equality of means, $\mu_1 = \mu_2$ [normal pops. when $\sigma_1 \neq \sigma_2$ but unknown]*

1. Suppose you are given two lists of data. First, enter the values into two lists (*e.g.* L1, L2). Press STAT, scroll over to TESTS, scroll down to Ø:2-SampTInt..., and press ENTER (see left image, below). Select Data as your input method (Inpt) [Stats is used when summary statistics are given], give the lists that contain the data (List1 & List2), be sure the frequencies (Freq1 & Freq2) are 1 since all of the data from each sample is in one list (otherwise give the list that contains the frequencies for each sample), select the appropriate alternative hypothesis (μ1:), and Pooled should be No since we think the unknown population standard deviations are not equal (see right images, below). When this is done, move the cursor to Calculate and press ENTER to view the results. (Note that the degrees of freedom, sample means, sample standard deviations, and sample sizes are displayed, respectively.)
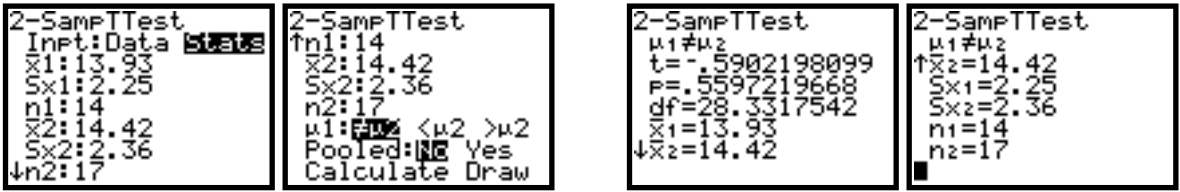

2. *Example:* The U.S. Bureau of Labor Statistics conducts monthly surveys to estimate hourly earnings of nonsupervisory employees in various industry groups. Results of the surveys can be found in *Employment and Earnings*. Independent random samples of 14 mine workers and 17 construction workers yield the following statistics.

Mining	Construction
$\bar{x}_1 = \$13.93$	$\bar{x}_2 = \$14.42$
$s_1 = \$2.25$	$s_2 = \$2.36$

At the 1% significance level, is there a difference between the mean hourly earnings of mine workers and the mean hourly earnings of construction workers?

Since we have summary statistics, we need not enter any data. Press STAT, scroll over to TESTS, scroll down to 4:2-SampTTest..., and press ENTER (see left images, below). Select Stats as your input method, enter for each sample the values of: mean, standard deviation, and sample size, select the appropriate alternative hypothesis (≠μ2), and Pooled should be No since we think the unknown population standard deviations (measures of variability) are not equal. When this is done, move the cursor to Calculate and press ENTER to view the results (see right images, below).

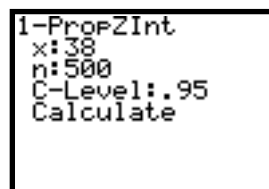Now you must present your hypothesis test analysis, incorporating your TI-83 results.

Inference on Proportions in the TI-83/84

I. *Confidence Intervals for the population proportion, π [when $n\hat{p} \geq 10$ and $n(1 - \hat{p}) \geq 10$]*

1. Confidence intervals using the standard normal distribution can be computed using the information in the text with a Standard Normal Table, using the information in the text with `invNorm` (see p. 9 of this document), or they can be computed directly with the TI-83.

    Suppose you are given summary statistics for a set of data (number of units with the characteristic of interest, *x*, and the sample size, *n*). First, press $\boxed{\text{STAT}}$, scroll over to `TESTS`, scroll down to `A:1-PropZInt`..., and press $\boxed{\text{ENTER}}$ (see left image, below). Enter the number of units with the characteristic of interest (`x`), give the sample size (`n`), and the confidence level (`C-Level`) should be entered as a decimal value (see right image, below). You may not be given the number of successes, but rather the sample proportion, p-hat, may be given. You can enter the following expression for x: $\hat{p} * n$ (be sure to round this answer to the nearest integer). When this is done, move the cursor to `Calculate` and press $\boxed{\text{ENTER}}$ to view the confidence interval.

    ```
    EDIT CALC TESTS
    7↑ZInterval…
    8:TInterval…
    9:2-SampZInt…
    0:2-SampTInt…
    A 1-PropZInt…
    B:2-PropZInt…
    C↓χ²-Test…
    ```
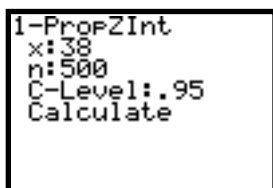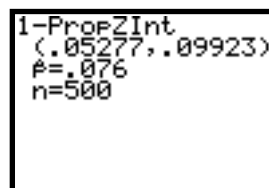   ```
    1-PropZInt
     x:38
     n:500
     C-Level:.95
     Calculate
    ```

2. *Example:* Studies are performed to estimate the percentage of the nation's 10 million asthmatics who are allergic to sulfites. In a recent survey, 38 of 500 randomly selected U.S. asthmatics were found to be allergic to sulfites. Find a 95% confidence interval for the proportion of all U.S. asthmatics who are allergic to sulfites.

    First, press $\boxed{\text{STAT}}$, scroll over to `TESTS`, scroll down to `A:1-PropZInt`..., and press $\boxed{\text{ENTER}}$ (see left image, below). Enter the number of units with the characteristic of interest (`38`), give the sample size (`500`), and the confidence level should be entered as a decimal value (`0.95`). When this is done, move the cursor to `Calculate` and press $\boxed{\text{ENTER}}$ to view the confidence interval. (Note that the computed value of the sample proportion $\hat{p}$ is displayed as is the user-entered value of the sample size, respectively)

    ```
    1-PropZInt
     x:38
     n:500
     C-Level:.95
     Calculate
    ```
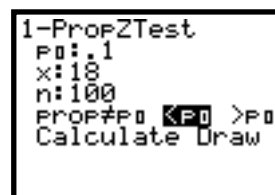   ```
    1-PropZInt
     (.05277,.09923)
     p̂=.076
     n=500
    ```

    "We can be 95% confident that the actual percentage of U.S. asthmatics that are allergic to sulfites is somewhere between 5.277% and 9.923%."

II. *Hypothesis Tests for the population proportion, $\pi$ [when $n\pi_0 \geq 10$ and $n(1-\pi_0) \geq 10$ ]*

1. Hypothesis tests using the standard normal distribution can be computed using the information in the text with a Standard Normal Table, using the information in the text with `invNorm` (see p. 9 of this document), or they can be computed directly with the TI-83.
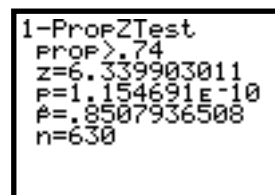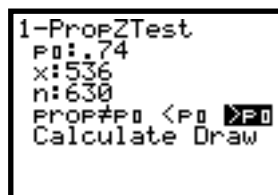
   Suppose you are given summary statistics for a set of data (number of units with the characteristic of interest, *x*, and the sample size, *n*). First, press $\boxed{\text{STAT}}$, scroll over to TESTS, scroll down to 5:1-PropZTest…, and press $\boxed{\text{ENTER}}$ (see left image, below). Enter the value of hypothesized proportion, $\pi_0$ (p₀), enter the number of units with the characteristic of interest (x), be sure the sample size (n) is entered, and select the appropriate alternative hypothesis (prop) (see right image, below). When this is done, move the cursor to Calculate and press $\boxed{\text{ENTER}}$ to view the results.

   ```
   EDIT CALC TESTS
   1:Z-Test…
   2:T-Test…
   3:2-SampZTest…
   4:2-SampTTest…
   5:1-PropZTest…
   6:2-PropZTest…
   7↓ZInterval…
   ```

   ```
   1-PropZTest
    P0:.1
    x:18
    n:100
   prop≠P0 <P0 >P0
   Calculate Draw
   ```

2. *Example:* In a 1993 study conducted by the American Management Association, 630 randomly selected major U.S. firms were polled on their drug-testing policies. According to the report, "…85% of the firms surveyed now test employees, applicants, or both." At the 5% significance level, do the data provide sufficient evidence to conclude that the percentage of major U.S. firms that drug-tested in 1993 exceeds the 1992 figure of 74?

   First, press $\boxed{\text{STAT}}$, scroll over to TESTS, scroll down to 5:1-PropZTest…, and press $\boxed{\text{ENTER}}$ (see left image, below). Enter the value of hypothesized proportion (0.74), enter the number of units with the characteristic of interest (536) [85% of 630 is about 536], be sure the sample size (630) is entered, and select the appropriate alternative hypothesis, $> \pi_0$ (>p₀) (see right image, below).

   When this is done, move the cursor to Calculate and press $\boxed{\text{ENTER}}$ to view the results. (Note that the alternative hypothesis, test statistic value, *p*-value, computed sample proportion, and user-entered sample size are given, respectively.)

   ```
   1-PropZTest
    P0:.74
    x:536
    n:630
   prop≠P0 <P0 >P0
   Calculate Draw
   ```

   ```
   1-PropZTest
   prop>.74
   z=6.339903011
   P=1.154691E-10
   p̂=.8507936508
   n=630
   ```

   Now you must present your hypothesis test analysis, incorporating your TI-83 results.

III. *Confidence Intervals for the difference of population proportions, $\pi_1 - \pi_2$ [when $n_1\hat{p}_1 \geq 5$ and $n_1(1-\hat{p}_1) \geq 5$ & $n_2\hat{p}_2 \geq 5$ and $n_2(1-\hat{p}_2) \geq 5$]*

1. Suppose you are given summary statistics for two sets of data (number of units with the characteristic of interest, *x*, and the sample size, *n*, for each data set). First, press $\boxed{\text{STAT}}$, scroll over to TESTS, scroll down to B:2-PropZInt…, and press $\boxed{\text{ENTER}}$ (see left image, below). Enter the number of units with the characteristic of interest for sample one (x1), give the size of sample one (n1), enter the number of units with the characteristic of interest for sample two (x2), give the size of sample two (n2), and the confidence level (C-Level) should be entered as a decimal value (see right image, below). You may not be given the number of successes, but rather the sample proportion, p-hat, may be given. You can enter the following expression for x1: $\hat{p}_1 * n_1$ and for x2: $\hat{p}_2 * n_2$ (be sure to round this answer to the nearest integer). When this is done, move the cursor to Calculate and press $\boxed{\text{ENTER}}$ to view the confidence interval.

```
EDIT CALC TESTS
7↑ZInterval…
8:TInterval…
9:2-SampZInt…
0:2-SampTInt…
A:1-PropZInt…
B:2-PropZInt…
C↓X²-Test…
```

```
2-PropZInt
x1:367
n1:500
x2:353
n2:524
C-Level:.95
Calculate
```

2. *Example:* Suppose you are told that the percentage of adult U.S. males who are married exceeds the percentage of adult U.S. females who are married. Further suppose that to check this claim, you randomly select 550 adult U.S. males and 575 adult U.S. females. You find that 367 of the males and 353 of the females are married. Determine a 90% confidence interval for the difference between the proportions of adult U.S. males and adult U.S. females who are married. Do your data provide sufficient evidence to support the claim? Explain your answer.

First, press $\boxed{\text{STAT}}$, scroll over to TESTS, scroll down to B:2-PropZInt…, and press $\boxed{\text{ENTER}}$ (see left image, below). Enter the number of units with the characteristic of interest from sample one (367), give the size of sample one (550), enter the number of units with the characteristic of interest from sample two (353), give the size of sample two (575), and the confidence level should be entered as a decimal value (0.90). When this is done, move the cursor to Calculate and press $\boxed{\text{ENTER}}$ to view the confidence interval. (Note that the computed values of the sample proportions $\hat{p}_1$ and $\hat{p}_2$ are displayed as are the user-entered values of the sample sizes, respectively.)

```
2-PropZInt
x1:367
n1:550
x2:353
n2:575
C-Level:.90
Calculate
```

```
2-PropZInt
(.00638,.10034)
p̂1=.6672727273
p̂2=.6139130435
n1=550
n2=575
```

"We can be 90% confident that the difference, $\pi_1 - \pi_2$, between the proportion of adult American males who are married and the proportion of adult American females who are married is somewhere between 0.00638 and 0.10034." Since the entire range of this interval is positive, we are 90% confident that the percentage of adult U.S. males who are married exceeds the percentage of adult U.S. females who are married.

IV. *Hypothesis Tests for the equality of population proportions,* H_0: $\pi_1 = \pi_2$ *[when $n_1\hat{p}_1 \geq 5$ and $n_1(1-\hat{p}_1) \geq 5$ & $n_2\hat{p}_2 \geq 5$ and $n_2(1-\hat{p}_2) \geq 5$]*
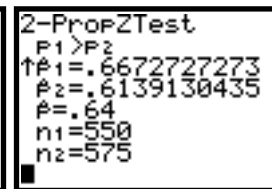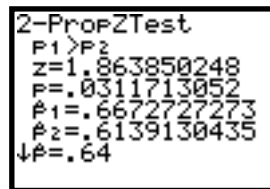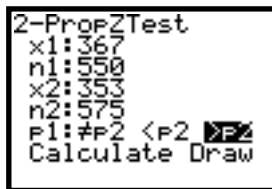
1. Suppose you are given summary statistics for two sets of data (number of units with the characteristic of interest, *x*, and the sample size, *n*, for each data set). First, press STAT, scroll over to TESTS, scroll down to 6:2-PropZTest…, and press ENTER (see left image, below). Enter the number of units with the characteristic of interest for sample one (x1), give the size of sample one (n1), enter the number of units with the characteristic of interest for sample two (x2), give the size of sample two (n2), and select the appropriate alternative hypothesis (p1:) (see right image, below). You may not be given the number of successes, but rather the sample proportion, p-hat, may be given. You can enter the following expression for x1: $\hat{p}_1 * n_1$ and for x2: $\hat{p}_2 * n_2$ (be sure to round this answer to the nearest integer). When this is done, move the cursor to Calculate and press ENTER to view the results.
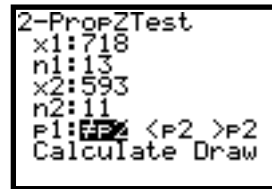
2. *Example:* Suppose you are told that the percentage of adult U.S. males who are married exceeds the percentage of adult U.S. females who are married. Further suppose that to check this claim, you randomly select 550 adult U.S. males and 575 adult U.S. females. You find that 367 of the males and 353 of the females are married. At the 5% significance level, do your data provide sufficient evidence to support the claim? Explain your answer.

First, press STAT, scroll over to TESTS, scroll down to 6:2-PropZTest…, and press ENTER (see left image, below). Enter the number of units with the characteristic of interest from sample one (367), give the size of sample one (550), enter the number of units with the characteristic of interest from sample two (353), give the size of sample two (575), and select the appropriate alternative hypothesis (>p2). When this is done, move the cursor to Calculate and press ENTER to view the results (right images, below). (Note that the alternative hypothesis, test statistic value, *p*-value, computed values of the sample proportions $\hat{p}_1$ and $\hat{p}_2$, pooled sample proportion $\hat{p} = \bar{p} = \dfrac{x_1 + x_2}{n_1 + n_2}$, and the user-entered values of the sample sizes are displayed, respectively.)

Now you must present your hypothesis test analysis, incorporating your TI-83 results.