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(developed at Brampton High School, Ontario by Fred Ferneyhough)

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Resetting the TI-83 Plus/84 Calculators

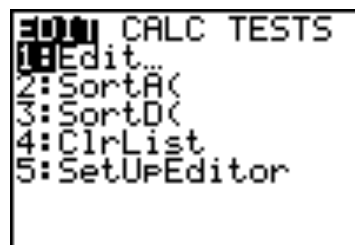
In general, to clear all memory from the calculator select 2nd and the + to access the MEM (memory) menu. Select 7:Reset and highlight ALL at the top of the screen. Press enter and all programs, data, apps, etc. will be erased.

Setting Up A Scatter Plot on the TI-84 Calculators

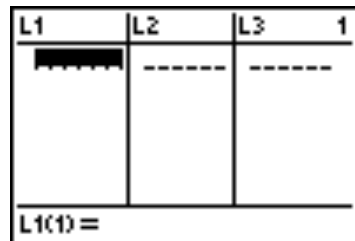
One of the first things that we do with the calculators is to enter data that we are going to graph and analyze. The following example will be used for the next few pages. It compares the temperatures in Celsius to Fahrenheit.

Temperature (Degrees Celsius)	Temperature (Degrees Fahrenheit)
0	32
5	41
10	50
15	59
20	68
25	77
30	86

In mathematics we always look for patterns. Describe the patterns in the numbers in these lists (each time that the Celsius temperature increases by 5, the Fahrenheit temperature increases by 9). Once we notice a numerical pattern, we could also graph the data using a type of graph called a scatter plot. A scatter plot is simply a set of points plotted either on graph paper or the calculator. To set this up on the calculator, you will need to get the points into the lists of the machine. To begin, press the STAT key to get the screen to the right.



When you press ENTER, you should see the following display. The calculator is now ready to accept your lists of data. As an example of this, use the table on the previous page.



For this example, we will say that the temperature in Fahrenheit depends upon the temperature in Celsius. The table above represents the corresponding temperatures in Celsius and Fahrenheit degrees. Since the Celsius temperatures are the independent variable, this information will be stored in List 1 (L_1) as shown in the diagram to the right. Start keying the numbers. Each time you complete a number, press ENTER and the cursor will move down to the next cell, like a spreadsheet program does. Note that, as you enter the final number in this list, the first number that you entered (0) has scrolled off the screen. When you are finished, press the right arrow button and the cursor will jump into the first cell in List 2 (L_2). Enter the values for Fahrenheit temperatures, the dependent variable, into L_2 .

L1	L2	L3	1
0	-----	-----	
5			
10			
15			
20			
25			
30			

L1(1)=0

L1	L2	L3	1
5			
10			
15			
20			
25			
30			

L1(8)=

When you are done, your lists should look like the diagram to the right. Now you are ready to set up the scatter plot.

L1	L2	L3	2
5	41		
10	50		
15	59		
20	68		
25	77		
30	86		

L2(8) =

A scatter plot on the TI-84 is set up through a feature called a STAT PLOT. To begin this process, press the 2nd key followed by the Y= button. You should get the screen to the right. Even though you can set up three different stat plots, we will rarely set up more than one at a time. Initially, the stat plots are all turned off. Press ENTER.

```

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

You will have to set up your screen to the same settings as shown in the screen on the right. You will see a cursor flashing on the word "On", with the word "Off" highlighted. Press ENTER and the word "On" will now be highlighted to indicate that the stat plot is active. The first choice in the "Type" section is the scatter plot option and it is already highlighted. Notice that the default choices for Xlist and Ylist are L_1 and L_2 respectively. In some activities, you will have to change this.

```

Plot1 Plot2 Plot3
On Off
Type: [Scatter] [Line] [Bar]
      [Dot] [Box] [Cross]
Xlist:L1
Ylist:L2
Mark: [Square] + .
  
```

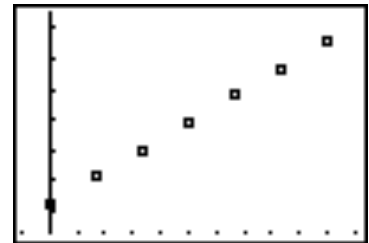
Now that the scatter plot is set up, it's time to graph it. To do this, press the Zoom key. This has ten different options that you can choose from.



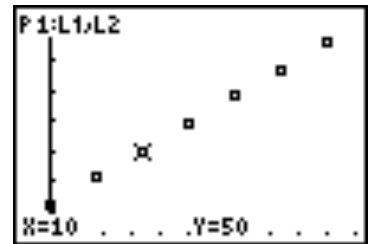
The one that we want is number 9, called ZoomStat. This will set up the screen to fit the coordinates of the points in your scatter plot.



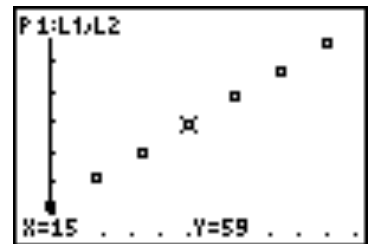
When you select this option, your screen should change to the same as the diagram to the right and you have a scatter plot on the calculator.



To interpret the diagram a bit better, press the Trace key and then the right arrow key. This will highlight the first few points in your data set with a flashing cursor and display the coordinates of the point at the bottom of the screen.

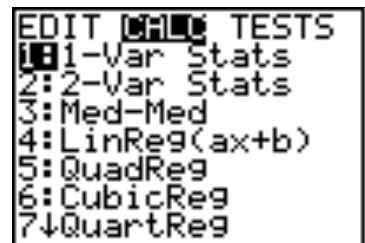


Each time that you press the right arrow button, the next point should be highlighted and its coordinates displayed at the bottom of the screen.



Finding the Line of Best Fit

A line of best fit is used when a scatter plot shows a set of points that seem to fall in a line or close to it. The calculator will find the best line easily and quickly. Begin by pressing the Stat key and moving to the right. You should get the screen to the right.



Select option 4, LinReg (ax + b). LinReg is an abbreviation for Linear Regression. Think of a regression as an activity where a line or curve is fitted to a set of points in a scatter plot. During the course, we will discuss the significance of the expression $ax + b$ in more detail.

```

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

When you select this option, the phrase "LinReg (ax +b)" is pasted into the home screen. You now have to tell the calculator what set of information to work with and where to store the result.

```

LinReg(ax+b) ■
    
```

First, you tell the machine which information to work with by indicating which lists represent the independent and dependent variables. For the example that we have been using, the independent variable is Celsius temperatures, found in L_1 and the dependent variable is Fahrenheit temperatures, found in L_2 . Put commas after each entry.

```

LinReg(ax+b) L1,
L2,
    
```

Finally, you have to indicate where to store the resulting equation. This will require a few steps. Press the Vars key and move to the right by pressing the right arrow. You should get the screen to the right.

```

VARS  [VAR]
1:Function...
2:Parametric...
3:Polar...
4:On/Off...
    
```

Press ENTER and the screen should change to match the diagram to the right. Press ENTER again to select Y_1 .

```

FUNCTION
1:Y1
2:Y2
3:Y3
4:Y4
5:Y5
6:Y6
7↓Y7
    
```

This choice is then pasted into the home screen to complete the instruction you had been working on. To make this command work, you will have to press ENTER again. When you do, you may see a small mark in the upper right corner of the screen. It indicates that the calculator is executing the command you have entered.

```

LinReg(ax+b) L1,
L2, Y1 ■
    
```

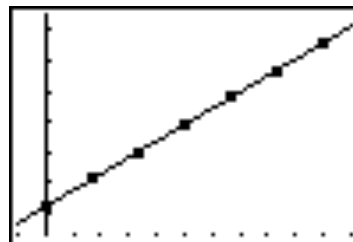
When it is done, you should see the following screen. The value of "a" represents the slope and the value of "b" represents the y-intercept. These ideas will be explained in detail if you don't already know them. Keep in mind that we said that the Fahrenheit temperature increased by 9 degrees each time that the Celsius temperature increased by 5 degrees and $9/5 = 1.8$. The fact that $r = 1$ indicates that this line is a perfect fit for the data. Note: In your Catalog turn Diagnostics On to see the r value.

```
LinReg
y=ax+b
a=1.8
b=32
r=1
r=1
```

When you selected Y_1 above, the calculator stored your result in an equation in the Y= list. To see this, press the Y= key. You will be doing this calculation many times in mathematics and should be able to state the equations you obtain.

```
Y1= 1.8X+32
Y2=
Y3=
Y4=
Y5=
Y6=
Y7=
```

To see the line of best fit, press the GRAPH key. A line is drawn on the screen. For this example, the line passes through all of the values. Not all regressions will produce a fit as good as this one. It will vary according to the data in the lists as the next example illustrates.



Look at the data in the screens to the right. The pattern that you were asked to observe was that for each five-degree rise in Celsius temperature, the Fahrenheit temperature increased by nine degrees. If the Celsius temperatures are not multiples of five, then the Fahrenheit temperatures are often rounded off to the nearest whole number as shown in these screens.

L1	L2	L3	2
20	68		
21	70		
22	72		
23	73		
24	75		
25	77		
26	79		

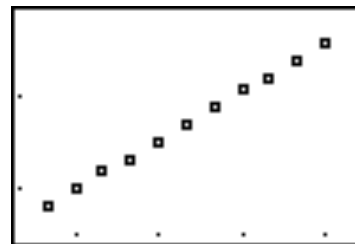
L2(7) = 79

RESET your calculator so that you are starting fresh. Press the Stat key followed by the ENTER key so that you can enter this data into List 1 and List 2. Review the steps listed above for setting up a scatter plot, change the screen as necessary.

L1	L2	L3	2
25	77		
26	79		
27	81		
28	82		
29	84		
30	86		

L2(12) =

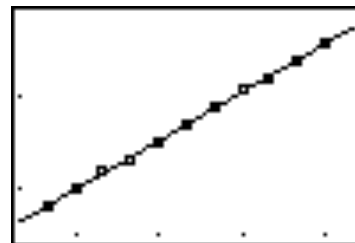
When finished, press the Zoom key, followed by the digit 9 to display the scatter plot. It appears that the points lie on a line as they did last time, so we should be able to use the calculator to find a line of best fit.



This time the equation is not as nice as it was the first time. This is due to the rounding of the Fahrenheit values when the conversion was done. The fact that r is close to 1 indicates that the fit is extremely good, but not perfect.

```
LinReg
y=ax+b
a=1.781818182
b=32.45454545
r2=.9978181818
r=.9989084952
```

Press the Graph key to see how the line of best fit suits the data points. You can see that the line passes through most of the points, but there are two or three that are off a bit. Not all data will fit as nicely as this set and the previous one. These work well because the two temperature scales have a relationship that can be calculated by a formula.



Throughout the math courses that you take, we will find many sets of data that are not perfect.

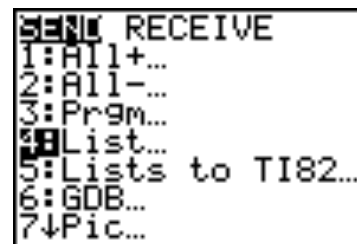
Transferring Data Between Calculators

Programs and large lists of data can easily be transferred from one calculator to another. To do this, connect two calculators with a unit-to-unit link cable. The port for this cable is located at the bottom of the machine. First, you set up the machine receiving the data. You will find the word "LINK" in above the key marked X,T,θ,n.

Press the 2nd key followed by this button. Move to the right so that the word "RECEIVE" is highlighted. Press ENTER. The screen should clear and display the message "Waiting...". This will remain in place for about a minute while you set up the other calculator.

```
SEND RECEIVE
RECEIVE
```

On the other machine, press the same LINK button, but do not move to the right. Your choice of options is shown in the diagram to the right. You can move any number of items, but have to highlight each one. Let's say that we want to move L1 and L2 to the other machine. Press ENTER to select the List option.



You should see a screen that looks like the one to the right. For each list that you want to transfer, press ENTER and a small rectangle will be displayed to the left of the item to indicate that it has been marked.



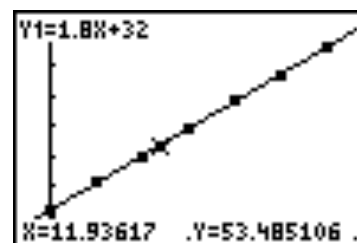
Do this for L1 and L2. When you have finished, press the \leftrightarrow key to highlight the TRANSMIT option. Press ENTER. As each item is transferred, it should be displayed on the receiving machine. Once this is complete, find classmates who need the information and transfer the data to them.



Using Tables of Values to Interpolate and Extrapolate

Quite often, you will use a line of best fit to find values that were not provided in the data. For the following work, you will need to create the scatter plot and line of best fit for the data given in the table from the first page. Recall that the table gives the temperatures in Celcius and Fahrenheit. The independent variable is the temperature in Celsius (plotted along the horizontal axis) and the dependent variable is the temperature in Fahrenheit (plotted along the vertical axis). We will look at two problems. First, find the Fahrenheit temperature if the temperature in Celsius is 23° . Since this represents a value of the independent variable that is between some of the data points, finding the answer to this is called **interpolation**. Second, find the Fahrenheit temperature if the temperature in Celsius is 37° . Since this represents a value of the independent variable that is outside of the values of the data points, finding the answer to this is called **extrapolation**.

One way to answer the first question is to press the Trace key on the TI-84 Plus. The cursor will likely be on one of the data points and the screen will likely indicate that you are looking at Plot 1 (in the top left corner of the screen). Press the \downarrow key and the display will show the equation at the top left of the screen. Use the \leftrightarrow key to move to the right



until the value of x is 12. Unfortunately, it is almost impossible to control the position of the cursor so that it is exactly 12. You may be able to get close enough to do an estimate, but not close enough to get a precise value.

To get around this, the calculator will display a table of values for any equation that has been entered into the $Y=$ editor. Since you have stored your equation in Y_1 , you can access this table of values. On your calculator, press the 2nd key, followed by the GRAPH key. (Note that the word "TABLE" is written above the GRAPH key). You should get a table like the one in the diagram.

X	Y ₁	
0	32	
1	33.8	
2	35.6	
3	37.4	
4	39.2	
5	41	
6	42.8	

X=0

Use the down arrow to scroll down to $x = 23$. You should see that the Celsius temperature of 23° corresponds to a Fahrenheit temperature of 73.4° .

X	Y ₁	
17	62.6	
18	64.4	
19	66.2	
20	68	
21	69.8	
22	71.6	
23	73.4	

X=23

To answer the second question, we can continue to scroll down until $x = 37$. You should see that the Celsius temperature of 37° corresponds to a Fahrenheit temperature of 98.6° . This is the temperature of the human body.

X	Y ₁	
35	95	
36	96.8	
37	98.6	
38	100.4	
39	102.2	
40	104	
41	105.8	

Y₁=98.6

It may take a long time to scroll down. To get around this, notice that there is a "TBL SET" option above the WINDOW key. Access this feature to change the value of TblStart to 35 and the value to the right of ΔTbl to 0.5.

TABLE SETUP		
TblStart=35		
$\Delta Tbl=0.5$		
Indent:	Auto	Ask
Depend:	Auto	Ask

Now, go back to the table. What was the effect of this operation? You should have found that the table of values began at $x = 35$. The ΔTbl value will cause the x values to increase in the table by whatever value you enter.

X	Y ₁	
35	95	
35.5	95.9	
36	96.8	
36.5	97.7	
37	98.6	
37.5	99.5	
38	100.4	

Y₁=98.6

A final way of doing these questions avoids the use of tables. When doing a line of best fit, you use the variable Y_1 to store the resulting equation in the $Y=$ editor.

Now that this has been done, you can enter Y_1 followed by the value of any x coordinate in brackets. When you press the ENTER key, the value displayed as an answer is the y -coordinate for that value of x . So, $Y_1(23) = 73.4$ represents the value of y when $x = 12$ and $Y_1(37) = 98.6$ represents the value of y when $x=37$.

$Y_1(23)$	73.4
$Y_1(37)$	98.6
■	

Finite Differences

The following set of data comes from the height of a ball thrown into the air from a height of 1.75 m with an initial velocity of 30 m/s. The data measured in the table represents the time, measured in seconds (s), and the height of the ball, measured in metres (m).

Time (s)	Height (m)	Differences		
		First	Second	Third
0	1.75	$26.85-1.75=25.1$	$15.3-25.1=-9.8$	
1	26.85	$42.15-26.85=15.3$		
2	42.15			
3	47.65			
4	43.35			
5	29.25			
6	5.35			

For this relationship, the height depends upon the time, so time is the independent variable and height is the dependent variable. Differences in the dependent variable help us determine what type of graph to use. We will be using these ideas in each grade and each course. If the first set of differences are equal, then the graph is linear and we perform a linear regression. If the first differences are not equal, then the graph is non-linear. Obviously, this relationship is non-linear. However, more information can be obtained by doing differences of the differences. If the second differences are equal then the relationship is called quadratic and we perform a quadratic regression. These ideas can be extended to third differences and so on.

In the table, the first two calculations for the first differences have been done. Copy the table and complete the first column of the table to get the first differences. Why can't you find a value for the last row? In the second column, the first of the differences has been calculated. Why can't the last two rows be calculated? Is this relationship quadratic? Why? When will the ball fall back to the ground?

Now, we will turn to doing this work on the calculators. Enter the data for the time and the height into List 1 and List 2 respectively.

L1	L2	3
0	1.75	-----
1	26.85	-----
2	42.15	-----
3	47.65	-----
4	43.35	-----
5	29.25	-----
6	5.35	-----
L3 =		

Enter the numbers 1 through 6 in L1 and the data shown in the above screen into L2. For L3, press LIST (the 2nd key followed by the Stat key) and scroll right to OPS. Choose option 7 (Δ List).

NAMES		MATH
1:	SortA(
2:	SortD(
3:	dim(
4:	Fill(
5:	seq(
6:	cumSum(
7:	Δ List(

The phrase " Δ List" will appear on the entry line. Since we want the differences in the y coordinates and they are stored in L2, enter L2 and close the brackets.

L1	L2	3
0	1.75	-----
1	26.85	-----
2	42.15	-----
3	47.65	-----
4	43.35	-----
5	29.25	-----
6	5.35	-----
L3 = Δ List(L2)		

When you press ENTER, the calculator will find the finite differences of L2 and store them in L3. Note that row 7 of L3 is blank.

L2	L3	4
1.75	25.1	-----
26.85	15.3	-----
42.15	5.5	-----
47.65	-4.3	-----
43.35	-14.1	-----
29.25	-23.9	-----
5.35	-----	-----
L4 =		

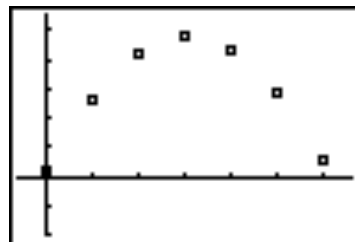
These differences were not equal, so we can conclude that the data in L1 and L2 did not form a linear relationship. To determine whether or not this data is quadratic, move over to the top of L4 and find the differences in L3 using the same steps as before.

L2	L3	4
1.75	25.1	-----
26.85	15.3	-----
42.15	5.5	-----
47.65	-4.3	-----
43.35	-14.1	-----
29.25	-23.9	-----
5.35	-----	-----
L4 = Δ List(L3)		

Since the second differences are equal, the data must be quadratic. Later, you will learn why the number "-9.8" is significant.

L2	L3	L4	4
1.75	25.1	-9.8	-----
26.85	15.3	-9.8	-----
42.15	5.5	-9.8	-----
47.65	-4.3	-9.8	-----
43.35	-14.1	-9.8	-----
29.25	-23.9	-----	-----
5.35	-----	-----	-----
L4(1) = -9.8			

Set up a scatter plot of the data to confirm your conclusions. The scatter plot shows the quadratic pattern.



Quadratic Regressions

Since we were able to find a line of best fit, it makes sense that we can also find curves of best fit. Start to find the regression equation by pressing Stat and ENTER. As before, the data is found in L₁ and L₂, and the result will be stored in Y₁. Press ENTER.

```

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

```

QuadReg L1,L2,Y1
█
    
```

The regression equation is displayed on the screen. Note that when the TI-84 Plus does a regression, it uses the letters of the alphabet for coefficients and constants and displays their values.

```

QuadReg
y=ax^2+bx+c
a=-4.9
b=30
c=1.75
R^2=1
█
    
```

Finally, graph the new equation with the scatter plot by pressing the σ key.



Finding a Maximum Value for a Graph

For non-linear functions, it might be necessary to find the maximum and minimum values of y. For this example, use the function shown in the diagram to the right and set up the window as given in the second screen shot.

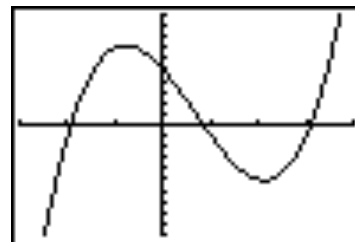
```

Plot1 Plot2 Plot3
\Y1 X^3-2X^2-5X+5
█
\Y2=
\Y3=
\Y4=
\Y5=
\Y6=
    
```

```

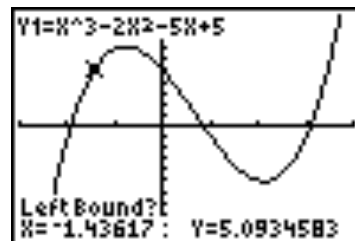
WINDOW
Xmin=-3█
Xmax=4
Xscl=1
Ymin=-10
Ymax=10
Yscl=1
Xres=1
    
```

The graph for the function is shown in the screen shot to the right. Using the Trace key, the function appears to have a maximum value of approximately 7 when x is close to -1 and a minimum value close to -5 when x is slightly bigger than 2. The next set of instructions will show how to find accurate values for these features.

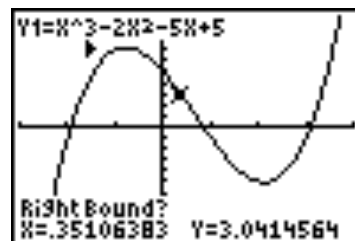


The device has a menu for finding features of graphs that can be accessed by pressing the 2nd key followed by the Trace key. We will be using the same menu for the next four operations. Like all menus on the TI calculators, there are two ways to call up an operation - either scroll down to option or just press the digit to the left of it. The second way is shorter, so press the digit 4 on your machine.

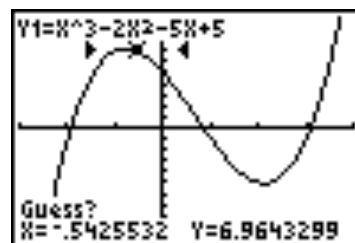
This will bring back the graph of the function with a cursor flashing on the graph and the message "Left bound?" at the bottom of the screen. Move the cursor to a point on the graph to the left of the maximum point. As you press the cursor keys the flashing cursor will move along the curve and the coordinates of each point will be displayed on the screen.



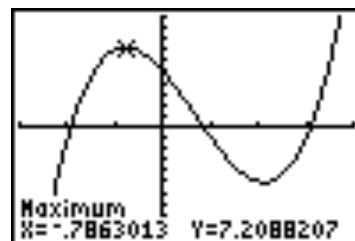
As you press the ENTER key, the screen will change in two ways. An arrow pointing to the right will appear above the x value you have selected, and the message at the bottom of the screen changes to "Right Bound?" This prompt indicates that you should move the cursor to the right of the maximum point. Press ENTER again.



As before, an arrow is placed on the screen and the message at the bottom changes, this time to "Guess?". You should now move the cursor to a location near the maximum point and press ENTER.

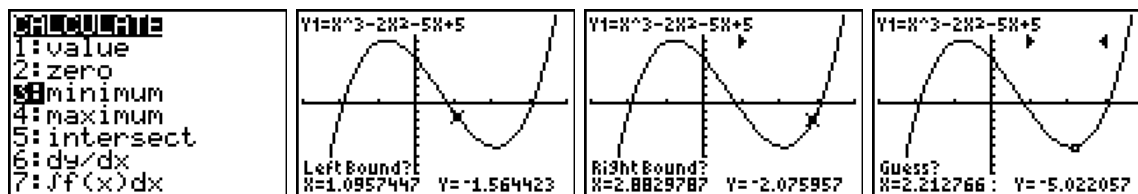


The cursor will jump to the exact location of the maximum point and the coordinates will be displayed at the bottom of the screen.

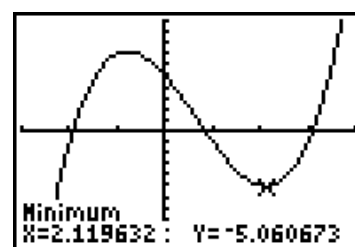


Finding a Minimum Value

Finding a minimum value works very similar to finding a maximum. Try to follow the work done in the screens below to duplicate the results. Note that the domain of the function has been changed to $X_{min} = -5$ and $X_{max} = 5$.

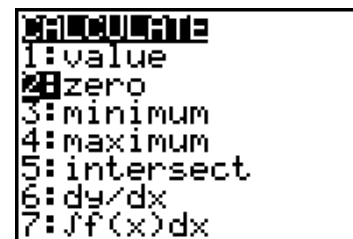


So, the minimum value of y is -5.06 when x is 2.12 .

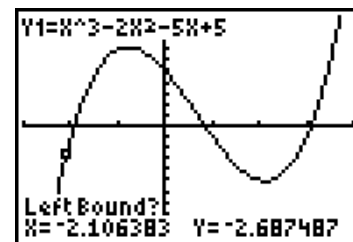


Finding an X-intercept

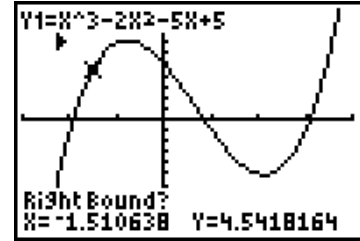
An x -intercept is the x -coordinate of a point where a graph crosses the x -axis. It is sometimes also called a zero of the function. With some functions, it is very difficult to find an x -intercept algebraically. We can use the zero feature on the machine to find an accurate value of any x -intercept. Once again, the CALC menu (press the 2nd and Trace keys) is used to begin the operation. Note that this operation will only find one of the roots and will have to be repeated if you are required to find all of the roots.



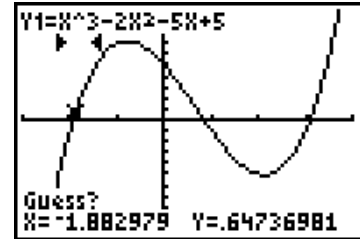
We will be working on the root to the left side of the screen with the same function as we used for the maximum and minimum operations. The procedure is similar to what you have already done for the maximum and minimum operations. First select a left bound, which is any point to the left of the x -intercept.



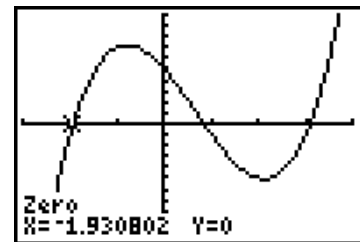
When you press ENTER, the prompt changes to "Right Bound?". You should move the cursor past the x-intercept to a point to the right of the zero.



Press ENTER and the prompt changes to "Guess?". Move the cursor to a point close to the x-intercept and press ENTER again.

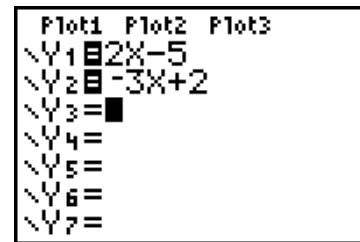


The exact values of the coordinates of the x-intercept will be displayed at the bottom of the screen.

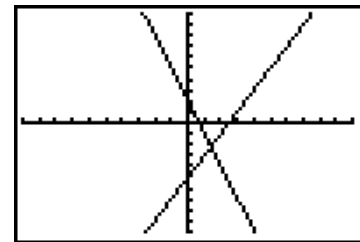


Finding the Point of Intersection

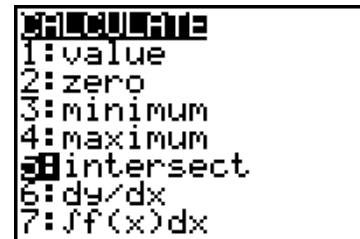
A point of intersection gives the x and y coordinates of a point that is found on both lines. Note for later courses: this procedure works for any two graphs. For this example, enter the equations as shown in the diagram to the right. This is sometimes called a system of equations. Finding the point of intersection is called solving the system.



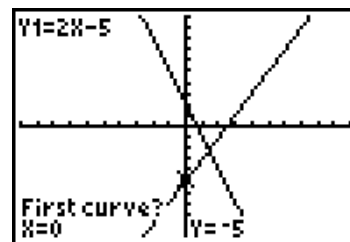
We will be finding the pointing of intersection of the two lines. Set the machine to a standard window (press the Zoom key followed by ÷). This will graph the system.



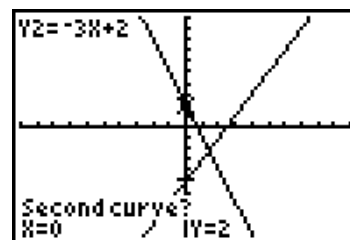
Call up the CALC menu again and choose the intersect operation.



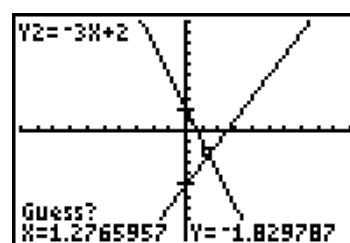
The graph will be displayed and the message "First curve?" appears at the bottom of the screen. Note that the digit 1 appears in the upper right corner. This is referring to the function that is stored in y_1 . Press ENTER.



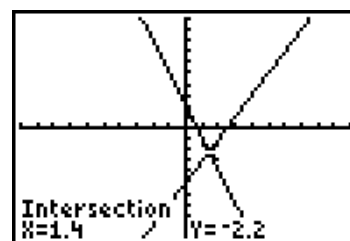
The graph changes and the message "Second curve?" appears at the bottom of the screen. Note that the digit 2 appears in the upper right corner. This is referring to the function that is stored in y_2 . Press ENTER.



Now that you have told the calculator which graphs to look at, you are being asked for a guess. Move the cursor close to the point of intersection and press ENTER.



The cursor should jump to the point of intersection and display the coordinates of the point of intersection at the bottom of the screen.



Sequences and Formulas in Lists

For this operation, you will be entering a set of numbers into a list. Generally, these sets follow a pattern (called a sequence). If you don't feel like entering each number, you can use the sequence operation to shorten the amount of work you need to do. First, make sure that all of the lists are cleared. To accomplish this, press the 2nd key, + key and 4 in succession. This will paste the command ClrAllLists on the home screen. Press ENTER.

Take the cursor to the top of the first list so that the title L_1 is highlighted. For this example, we will be entering the first ten perfect squares into list 1.

L_1	L_2	L_3	1
-----	-----	-----	
L1 =			

Press the 2nd key followed by the Stat key to access the LIST menus. Move to the right to access the OPS sub-menu and choose option 5 (seq is an abbreviation for sequence).

```

NAMES 0:2 MATH
1:SortA(
2:SortD(
3:dim(
4:Fill(
5:seq(
6:cumSum(
7:↓List(
  
```

The phrase "seq(" is pasted onto the entry line at the bottom of the screen.

L1	L2	L3	1
-----	-----	-----	
L1 =seq(

Complete the expression so that it reads seq(x², x, 1, 10). You should read this as "enter the set of numbers x² such that x goes from 1 to 10). Another way to enter this command it to key in seq(x², x, 1, 10,1). The extra digit at the end indicates how the values of x will increase. If it is not used, the calculator assumes that the increment will be 1.

L1	L2	L3	1
-----	-----	-----	
L1 =seq(X ² , X, 1, 10			

When you press ENTER, List 1 is filled with the perfect squares.

L1	L2	L3	1
1 4 9 16 25 36 49	-----	-----	
L1(1) = 1			

As another example of the same type of operation, let's say that we want to put a second sequence into L₂. This list will begin at 1 and end at 10, but will step up in intervals of 0.5. The entry line at the bottom of the screen should be seq(x,x,1,10,.5).

L1	L2	L3	2
1 4 9 16 25 36 49	-----	-----	
L2 =...(X, X, 1, 10, .5			

When you press ENTER, the sequence will be placed into L₂.

L1	L2	L3	2
1 4 9 16 25 36 49	1.5 2 2.5 3 3.5 4	-----	
L2(1) = 1			

Clear the lists again and begin the next set of steps by putting the numbers from 1 to 10 into L1. (do this by placing the cursor on the title, L₁, and entering the command seq(x,x,1,10).

L1		L3	2
1	-----	-----	
2			
3			
4			
5			
6			
7			
8			
9			
10			
L2 =			

Now, we want L₂ to have the numbers from 2 to 20. This could be entered as a sequence, or you could say that each number in L₂ is twice the value of the corresponding number in L₁. Take the cursor to the top of L₂ and enter the command 2*L₁. You should use quotes around the expression. The use of quotes will cause the calculator to remember the formula that you entered. Then, if you change L₁, the values in L₂ will automatically be updated.

L1		L3	2
1	-----	-----	
2			
3			
4			
5			
6			
7			
8			
9			
10			
L2 = "2*L1"			

Notice that L₂ has a symbol on the title line. This is to indicate that your formula has been saved into memory. Each time you change List 1, the values in List 2 will be updated automatically. Scroll down to the bottom of the lists. There should be ten numbers in each list. Go back to the top of L₁ and change the sequence so that L₁ contains the first 20 numbers. Did the values in L₂ update?

L1	L2	L3	2
1	2	-----	
2	4		
3	6		
4	8		
5	10		
6	12		
7	14		
L2(1)=2			

Statistical Graphs – Line Graphs, Bar Graphs and Histograms

The following table summarizes the rainfall/snowfall pattern in the GTA in one year. The numbers in the second column represent the number of days of precipitation during that month.

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Number	4	4	6	10	11	9	9	10	9	10	10	6

Since the independent variable is the month of the year, this data is continuous and we will use a histogram to represent the data graphically. Rather than using the names of the months, we will use the numbers 1 through 12 to represent the months of the year. The month numbers are stored in L₁ (using a sequence) and the number of rainy/snowy days each month is stored in L₂.

	L2	L3	1
1	4	-----	
2	4		
3	6		
4	10		
5	11		
6	9		
7	9		
L1 = {1, 2, 3, 4, 5, 6...			

	Plot2	Plot3	
	Off		
Type:			
Xlist:	L1		
Ylist:	L2		
Mark:			

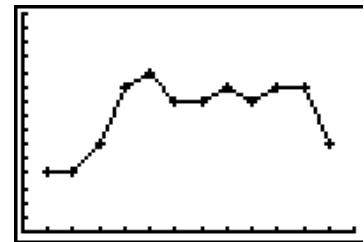
One way to represent this data is with a broken line graph. Press the 2nd key followed by the Stat key to set up the STAT PLOTS as before. However, this time, highlight the broken line graph option in the second line.

Create an appropriate window for the data set, or press Zoom key followed by the digit 9. One such window is shown to the right.

```

WINDOW
Xmin=0
Xmax=13
Xscl=1
Ymin=0
Ymax=15
Yscl=1
Xres=1
    
```

Press the GRAPH key to display the graph.



We could also display this data as a histogram. Press the 2nd key followed by the Y= key to access the STAT PLOT menu. Set up the features as indicated to the right. Note that the bar graph option has been selected in the second row.

```

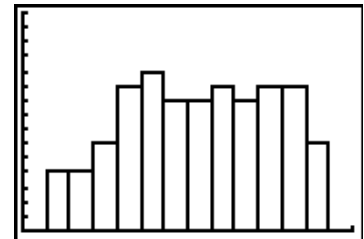
Plot1 Plot2 Plot3
Off
Type: [Bar] [Line] [Pie]
      [H] [N] [L]
Xlist:L1
Freq:L2
    
```

Press the WINDOW key and set up the window as shown in the screen to the right.

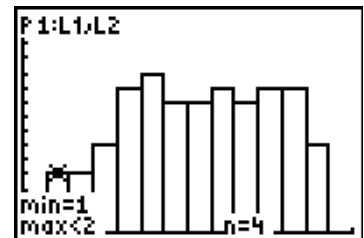
```

WINDOW
Xmin=0
Xmax=14
Xscl=1
Ymin=0
Ymax=15
Yscl=1
Xres=1
    
```

Press the GRAPH key to show the histogram. From the STAT PLOT set up, we should note that the numbers in L₁ are plotted horizontally and the numbers from L₂ determine the height of each graph. In the window setting, the Xscl value of 1 determines the width of each bar.

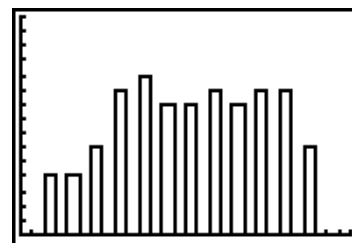


Press the Trace key and move the cursor to the right. Note that, for the first bar, the frequency of 4 is indicated on the bottom of the screen at the right. On the left, it is indicated



that the width of the bar is determined by the domain $1 \leq x < 2$. What happens if the Xscl is changed?

This graph shows exactly the same data set with Xscl = .5. Since the domain for the first bar is $1 \leq x < 1.5$, we get a narrower bar than above. In addition, we get a space in the interval $1.5 \leq x < 2$ since the values in this range do not appear in L_1 .

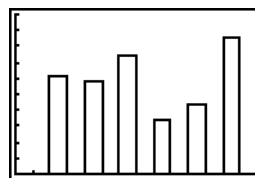
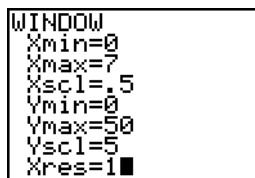
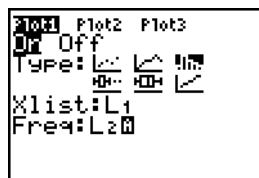
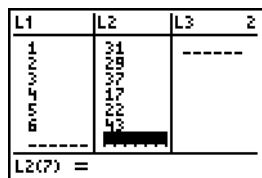


We can use this to set up a bar graph where a space between bars is required. In the next table, the data represents the number of athletic shoes purchased in several categories.

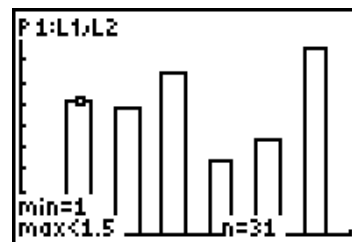
Category Number	Type of Shoe	Number Purchased
1	Basketball	31
2	Tennis	29
3	Golf	37
4	Running	17
5	Aerobics	22
6	Walking	43

Since the categories are the independent variable, this set of data is not continuous, so we will use a bar graph to represent the data.

The screens below show the work that must be done to create the bar graphs.



Press the Trace key and move to the right. Note that, for the first bar, the frequency of 31 is indicated on the bottom of the screen at the right. On the left, it is indicated that the width of the bar is determined by the domain $1 \leq x < 1.5$. If the \sim key is pressed again, the next interval will be $1.5 \leq x < 2$. Since there are no data values in L_1 in this interval, no bar is drawn.



One Variable Statistics

The final marks for 111 students in MFM 1P0 have been stored in L_1 . The principal wants to know some information about how the class has done.

L_1	L_2	L_3	1
62	-----	-----	
67			
65			
64			
70			
70			
58			

$L_1 = \{62, 67, 65, 64, \dots\}$

Press the Stat key and cursor to the right to access the statistical calculations menu. The first option is used to find the statistics related to a single list of data.

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

Press ENTER and complete the command by indicating that the analysis should be done on L_1 .

1-Var Stats L_1

Press ENTER again and the machine will find a number of results shown on the two screens to the right.

1-Var Stats
$\bar{x}=67.52252252$
$\Sigma x=7495$
$\Sigma x^2=508599$
$Sx=4.784153477$
$\sigma x=4.762554479$
$\downarrow n=111$

1-Var Stats
$\uparrow n=111$
minX=56
$Q_1=65$
Med=67
$Q_3=71$
maxX=82

There are more results here than we need in grade nine, but all of these will be used later in grade twelve. The first result indicates that the mean is 67.52. The value of “n” represents the number of students’ marks in the calculations and the Med indicates that the middle mark of the ordered set of data is 67.

Using the Calculator with the CBR

CBR is an acronym for the Calculator Based Ranger. Think of this as a simplified radar detector. The device is an attachment that links to the calculator. When activated, it sends out a signal that measures the distance from the device to an object in front of it. The TI-84 Plus has software that drives the CBR.

To begin work with the CBR, press the APPS key. Scroll down to the option labelled CBL/CBR. Press ENTER.



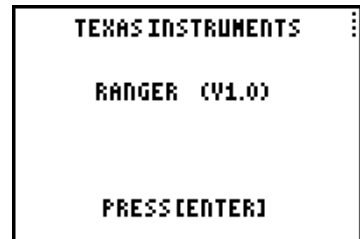
You will see the standard Texas Instruments copyright screen. Press ENTER.



When the menu appears, select the RANGER option. Just in case you are curious, the second option, DATA LOGGER, is used to connect the device to the CBL, the Calculator Based Laboratory.



Now, you get yet another advertisement for Texas Instruments. Press ENTER.



We will be selecting APPLICATIONS from the next menu.



Since we differ from our American friends, choose METERS for the unit of measure.



There are two applications that we use in grade nine and ten – the distance time match and the ball bounce. Since the device is connected to the CBR, screens cannot be captured to show the rest of the work.

