Blue Pelican

Calculator Appendices
for Algebra I and Geometry

Version 1.01

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Graphing Calculator Appendices for Alg 1 and Geometry

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Calculator Appendix A

(Nesting Groups)

Consider this problem in which there are multiple levels of nesting groups of arithmetic operations. . . {}, [], and ():

$$5\{\, 2[2 - 4(6 - 1)] - 8\}$$

The procedure for working this is to first simplify in the inner most nested group. In this case it's (6 − 1) = 5, so we get:
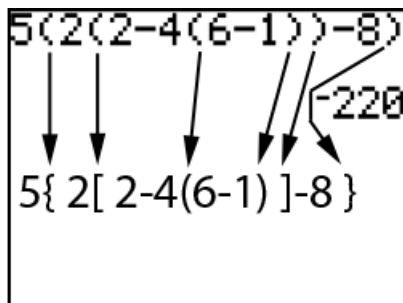
$$5\{\, 2[2 - 4(5)] - 8\}$$

Now simplify inside the inner most group, [2 − 4(5)] = [2–20] = −18 to get:

$$5\{\, 2[-\, 18] - 8\}$$

Finally, simplify inside the curly braces to get:

$$5\{-36 - 8\} = 5\{-44\} = \boxed{-220}$$

Now that we know what the answer is, how would we enter this into the calculator (and hopefully get the same answer) since curly braces and square brackets on the calculator have **other special use**s?

Use **parenthesis** for **all** grouping symbols.
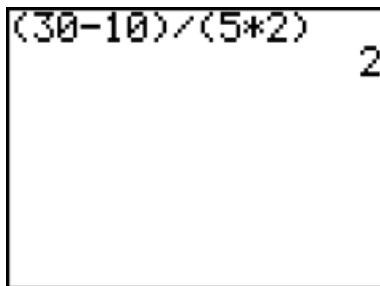
Calculator display

Calculator Appendix B

Grouping numerators and denominators

Consider the following problem that is to be entered in a graphing calculator:

$$\frac{30 - 10}{5 \cdot 2}$$

The division symbol in the calculator is "/" and this presents special problems when entered into the calculator.

To avoid problems, enter the problem as follows with the entire **numerator in parenthesis** and the **entire denominator in parenthesis**.

```
(30-10)/(5*2)
                2
```

Notice both the numerator and denominator completely enclosed in parenthesis.

Calculator display

If this problem is **improperly** entered with **no parenthesis**, it would look like this:

$$30 - 10/5*\ 2$$

Following the rules of PEMDAS we do **not** get the correct answer of 2:

$$30 - 10/5*\ 2 = 30 - 2*2 = 30 - 4 = 26$$

Always put parenthesis around the **entire numerator** and the **entire denominator**. True, there are occasions when this is not necessary; however, it never does any harm… **so always do it!**
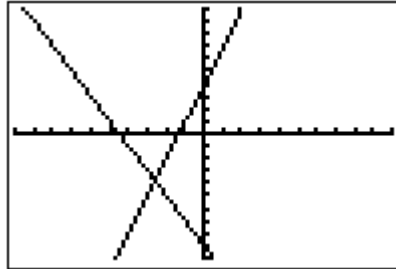
Calculator Appendix C

(Finding intersection points)

Consider finding the intersection point of two functions (y = 3x + 4 and y = -2x – 9). With **Y=**, enter the two functions and press **GRAPH**.

To initiate the process of finding the intersection, press **2nd | CALC**. From the resulting menu choose **5: intersect** by pressing the **DOWN ARROW** button thus moving the cursor all the way down to **5:** and then pressing **ENTER**, or by pressing the **5** button.
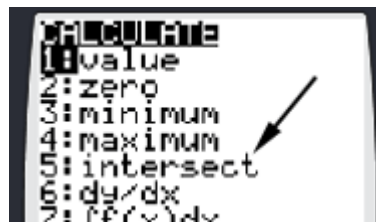
The next screen will show the graph along with a question, "First curve?". It is asking for either one of the curves. A blinker will be positioned on one of the "curves" (actually a line in this example) that is coincidentally also on the y-axis in this example.

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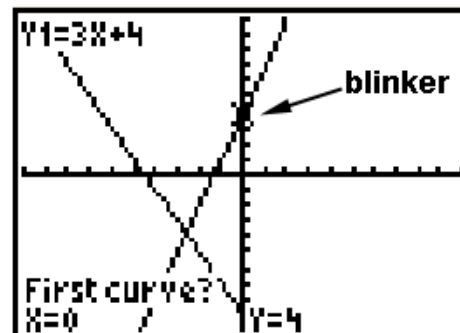
The blinker can be moved along the present curve with the **LEFT/RIGHT ARROWS** (The **UP/DOWN ARROWS** jumps between curves). When satisfied that the blinker is distinctly on one of the curves, press **ENTER**.

At this point another question will appear asking for the second curve.
Again, move the blinker with the **LEFT/RIGHT ARROWS** until satisfied that the blinker is distinctly on the other curve. Press **ENTER**.
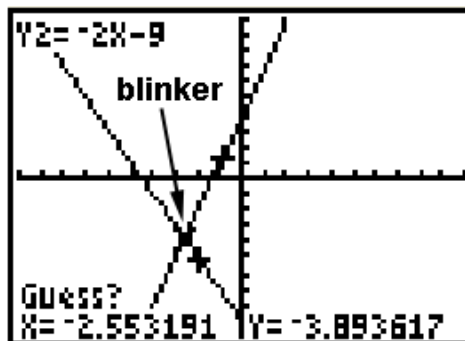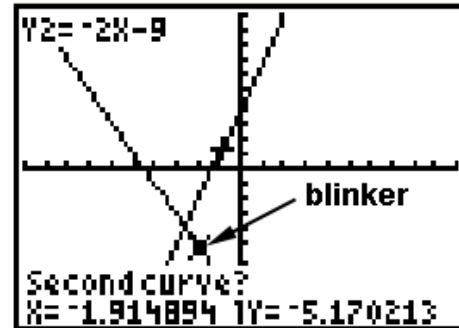
Finally, a third question is presented asking for a, "Guess?" Using the **LEFT/RIGHT ARROWS**, position the blinker approximately over the intersection point and press **ENTER**.

Students often ask why a guess is necessary. It's because the curves are often more complicated than our simple example and **intersect in more than one point**. The calculator needs to know which point we want, so the software inside the calculator insists on a "guess" in all cases.

The coordinates of the point of intersection are now shown at the bottom of the graph screen.

For simple cases like that depeicted here in which there is only one intersection point, it is possible to get the answer with three quick **ENTERS**'s after choosing **5: intersect**. (No need to adjust positions with the **LEFT/RIGHT ARROWS**.)
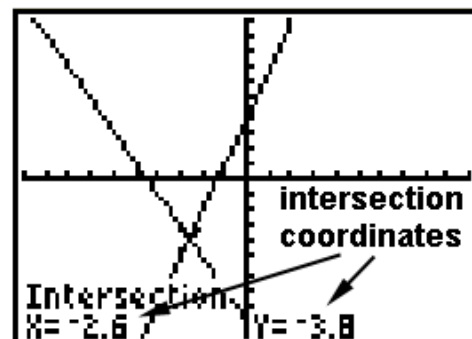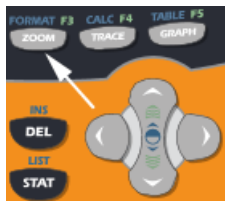
Calculator Appendix D

(Graphing a linear function)

Consider the graph of the linear function f(x) = x + 2. First, replace f(x) with *y*, so the function now reads y = x + 2.
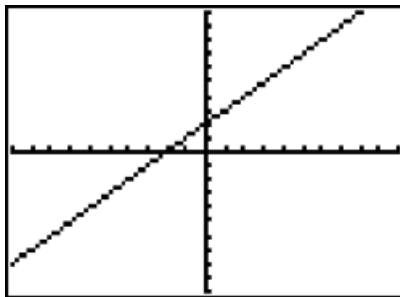
Press the **Y=** button and enter x + 2 just after **Y1 =**.

```
Plot1  Plot2  Plot3
\Y1■X+2■
\Y2=
\Y3=
\Y4=
\Y5=
\Y6=
\Y7=
```

Next set the zoom level by pressing the ZOOM button. Choose **6. ZStandard** which will display a graph spanning from negative to positive 10 in both the *x* and *y* directions.

```
ZOOM  MEMORY
1:ZBox
2:Zoom In
3:Zoom Out
4:ZDecimal
5:ZSquare
6:ZStandard
7↓ZTrig
```

The graph of the linear function entered as **Y1** will immediately display.

If the zoom level is already set, then the graph can be produced immediately after entering the function **Y1** by pressing the **GRAPH** button.

Calculator Appendix E

Comparing linear graphs

In this document we are going to demonstrate how to graph two linear functions at the same time so that the effect of changing attributes (slope and/or y-intercept) can be observed.

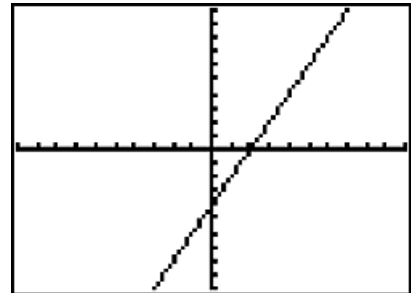The two function to be graphed are:

y = 2x – 4   and   y = 2x + 6

Begin by pressing the **Y=** button.
Beside **Y1** =, enter 2x – 4.

```
Plot1  Plot2  Plot3
\Y1=2X-4
\Y2=
\Y3=
\Y4=
\Y5=
\Y6=
\Y7=
```
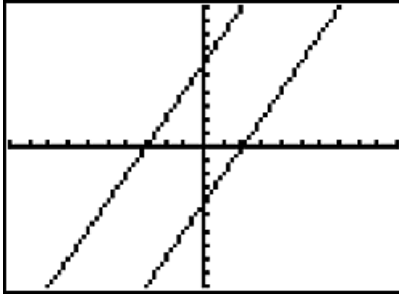
Then press the **GRAPH** button.

The **Y1** graph is now displayed.

Next, press **Y=** again and then press the **Down Arrow** to move down to **Y2 =** where the second function, 2x + 6, is entered.

```
Plot1  Plot2  Plot3
\Y1=2X-4
\Y2=2X+6
\Y3=
\Y4=
\Y5=
\Y6=
\Y7=
```

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Press the **GRAPH** button again and observe that both functions are graphed.

Comparing the two lines, we observe that the two lines are **parallel** since they both have the **same slope** value of 2. The lower line corresponding to **Y1** passes through the y-axis at -4 as predicted by the -4 in y = 2x – 4.

Likewise, the top line corresponding to **Y2** correctly passes through its predicted y-intercept value of 6.

Further comparisons can be made, for example, by modifying the slopes of the two functions. The line with a slope of largest absolute value will be observed to be steeper.

Make one slope positive and the other negative and observe that one lines goes up and the other down. Even more lines could be displayed by entering functions for **Y3**, **Y4**, etc.

Calculator Appendix F

Evaluating a function at a particular *x* position

We will consider the linear function f(x) = 4x – 7 being evaluated at x = 3. The answer is:
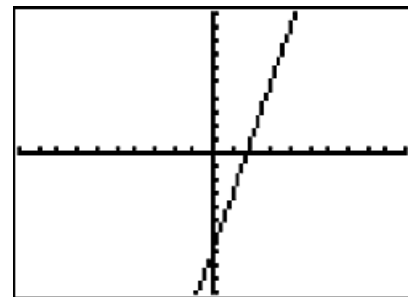
f(3) = 4(3) – 7 = 5

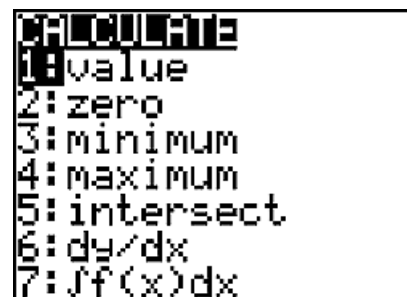To obtain this answer on a graphing calculator, press the **Y=** button and enter **Y1** as 4x – 7.

```
Plot1  Plot2  Plot3
\Y1■4X-7
\Y2=
\Y3=
\Y4=
\Y5=
\Y6=
\Y7=
```
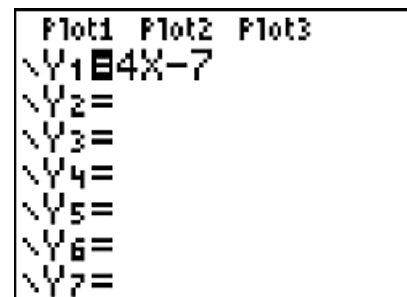
Now press the **GRAP**H button.

The graph of this function displays.

To evaluate this function at a particular value of *x*, press **2nd Calc** and this menu results. Choose **1. Value**

```
CALCULATE
1■value
2:zero
3:minimum
4:maximum
5:intersect
6:dy/dx
7:∫f(x)dx
```

At the bottom of the display an **x =** appears inviting us to enter the *x* value at which we want the function evaluated. Enter **3** and then press **ENTER**.

X=█
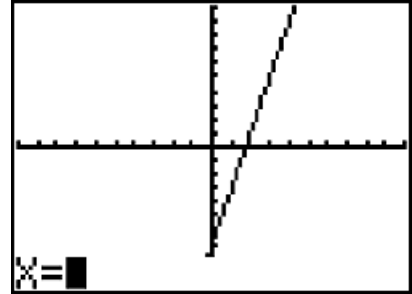
Finally, we get this display and at the bottom where we see the answer, **Y = 5**. Also notice that an x marks the place on the graph of the function at which the function is being evaluated.

Y1=4X-7

X=3   Y=5
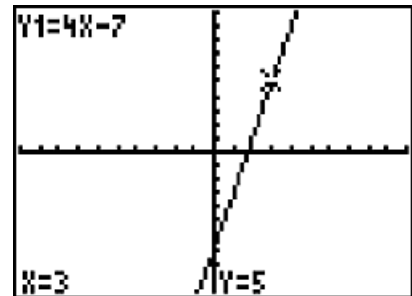
Calculator Appendix G

(Tables)

Our goal here is to produce a table on the calculator similar to this:

x	y = f(x) = .42x + 1.50
1	y = (.42)1 + 1.50 = 1.92
2	y = (.42)2 + 1.50 = 2.34
3	y = (.42)3 + 1.50 = 2.76
4	y = (.42)4 + 1.50 = 3.18

First, we must enter the function.
Press **Y=** and enter .42x + 1.5 for **Y1**.

Next, we must "set-up" the table by pressing **2ND TBLSET**. Make the entries as shown here.

TblStart = 1 indicates that we want our *x* values to start at 1. **ΔTbl = 1** indicates that the *x* values in the table increase by 1 for each new row.

Indpnt: Auto indicates that the *x* values (left column) are automatically generated starting at **TblStart** and incremented by **ΔTbl**.

Depend: Auto indicates that the *y* values (2nd column) are automatically evaluated from the **Y1** function using the corresponding *x* values of column 1.

To produce the table, press **2nd TABLE**. The table displays as shown here:

X	Y1	
1	1.92	
2	2.34	
3	2.76	
4	3.18	
5	3.6	
6	4.02	
7	4.44	
X=1		

To see more entries beyond x = 7, keep pressing the **DOWN ARROW**. To see more decimal places of accuracy in the **Y1** column, use the **RIGHT ARROW** to highlight the desired position.
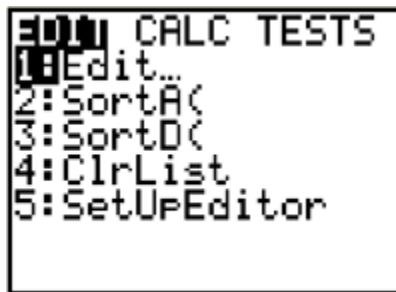
Calculator Appendix H
(Scatter Plots)

x	y
-9	-2.1
-5.2	-1
-2	2.04
2.3	5
6	6.11
8.9	8.2

Consider the data in this table. These points can be displayed as a "scatter-plot" with the steps described below.

The first step is to press the STAT button which yields the following display.

At this point either press **ENTER** or **1** indicating we wish to choose menu item 1 (editing/ entering the list of x and y values).

Enter the *x* and *y* values choosing each position with the **Left/Right** & **UP/DOWN ARROWS.** Enter the *x* values under list **L1** and the *y* values under list **L2**.

If **L1** and **L2** are not visible use the **LEFT/RIGHT ARROWS** so they display. If old lists are present us the **UP ARROW** to position the cursor on top of, for example **L1**, press **CLEAR**, and press **ENTER**.

The next step will be to press **2nd | STAT PLOT | 1 | On** so as to enable a scatter-plot to be displayed. This sequence is shown below. In the picture on the far right, use the **LEFT/RIGHT ARROWS** to choose between **On** and **Off** (choose **On**).

Finally, display the scatter plot by pressing the **GRAPH** button.

See **Appendix I** for how to produce the equation of a line that "best - fits" this scatter-plot.

Calculator Appendix I

(Linear Regression)

The process of regression is finding a function that "best-fits" a scatter-plot. In this Appendix a **linear regression** that determines the best-fit of a line will be demonstrated. Shown below is the data and the resulting scatter-plot from **Appendix H** that will be used here. That Appendix shows how to enter the data and produce the scatter-plot.

L1	L2	L3	2
-9	-2.1	------	
-5.2	-1		
-2	2.04		
2.3	5		
6	6.11		
8.9	8.2		
------	------	------	

L2(1)= -2.1

```
WINDOW
  Xmin=-10
  Xmax=10
  Xscl=1
  Ymin=-10
  Ymax=10
  Yscl=1
  Xres=1
```
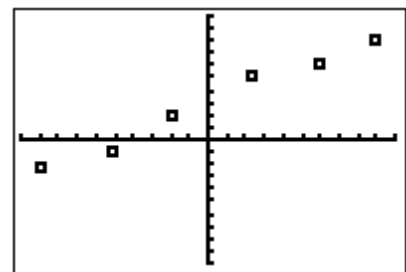
With the above data already in the lists **L1** (the *x* values) and **L2** (the *y* values), press the **STAT** button. With the **RIGHT ARROW** move to **CALC** and then with the **DOWN ARROW** down to **4: LineReg(ax+b)**.

Press **ENTER** twice to produce the *a* and *b* values defining the best-fit line:

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

```
LinReg
  y=ax+b
  a=.5943811682
  b=2.942603139
```

At this point we could press **Y=** and enter:

Y1 = .5943811682X+2.942603139

However, there is an easier way. Rather than having to manually enter the *a* and *b* values for **Y1**, it is possible to automatically have them entered.

With the cursor on **Y1=** (on the **Y=** screen), press the **VARS** button, choose **5: Statistics**, **RIGHT ARROW** across to **EQ**, and then down to **1: RegEQ**. At this point the regression equation for the best-fit is automatically entered for **Y1**.
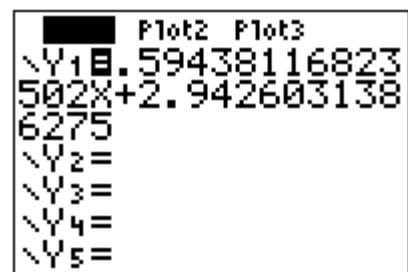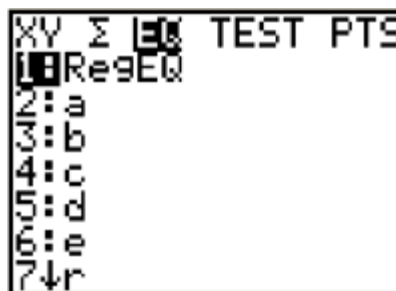
Press **GRAPH** and if **STAT PLOT** is still enabled (see **Appendix H**), the following should display as the best-fit for for the scatter-plot.
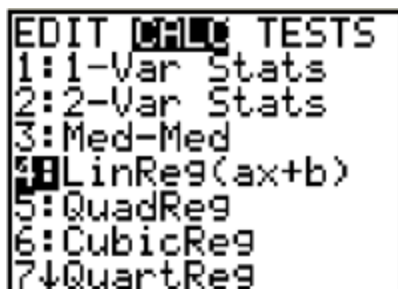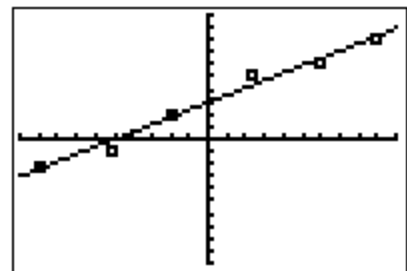
Some data does not lend itself to being best-fit with a line. For data that obviously "curves", other type regressions are available (parabolic (QuadReg), cubic, exponential, etc.)

When doing various regressions on a set of data points, it is possible to get "scores" on the quality of each fit.

First, it will be necessary to turn on "diagnostics" so that a score can be displayed. Press **2ND| CATALOG**, **Down ARROW** down to **1: Diagnostics ON**, and press **ENTER** twice to turn on diagnostics.
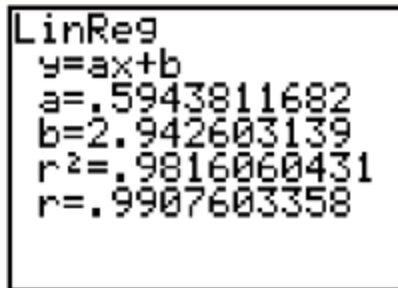
With diagnostics on, a regression will now display r^2 = "some number less than or equal to one". Shown here is the same linear regression as above except now r^2 = .9816060431 is displayed along with a corresponding *r* value. r^2 is the square of the **correlation factor**, *r*, which can range from -1 to 1.

To eliminate the sometimes confusing negative *r* values, r^2 is often given as a figure of merit, were of, of course, r^2 = 1 is a **perfect score** as a result of a perfect fit.

For a linear regression, a negative *r* value indicates that the line of best-fit has a negative slope and the **correlation is said to be negative**. Likewise, a best-fit line with a positive slope is represented with a positive value of *r* and the **correlation is side to be positive**.

Calculator Appendix J

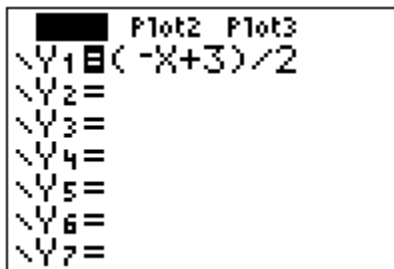## (Graphing inequalities in two variables)

Consider the display of the following inequality on a graphing calculator.

x + 2y ≥ 3

The first step is to solve for y:

y ≥ (-x + 3)/2

Press the **Y=** button on the calculator and enter (-x + 3)/2 for **Y1**. Press **GRAPH** and observe that a **line** is graphed:
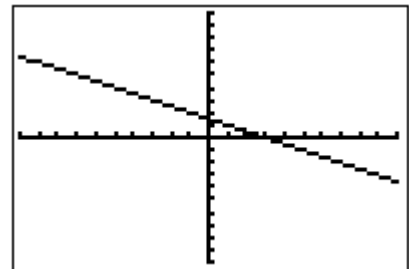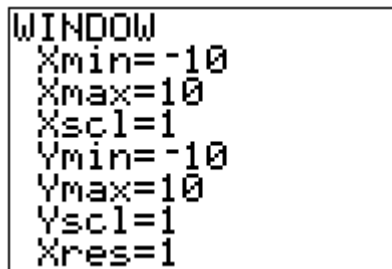
In order to turn this into a true inequality with a shaded region, use the **LEFT ARROW** to move the cursor to the left of **Y1 =**. Once the cursor is in that position, repeatedly press **ENTER** until this icon (◥) appears. This causes the function (in this case a line) to be shaded **above**. Press **GRAPH** again and shading will be observed **above** the line.
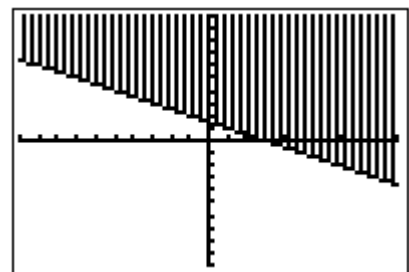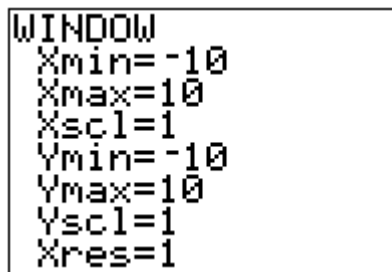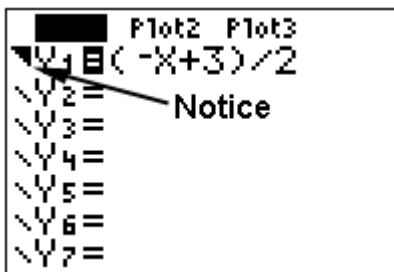
To graph the inequality y ≤ (-x + 3)/2 which will require shading **below** the line, use the **LEFT ARROW** to move the cursor to the left of **Y1 =**. Once the cursor is in that position, repeatedly press **ENTER** until this icon (▙) appears. Press **GRAPH** and shading will be observed **below** the line.
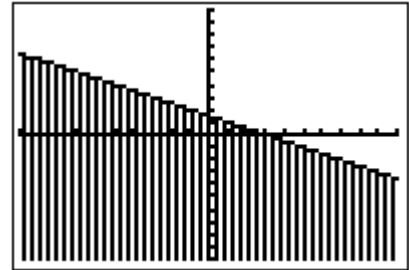
■ Plot2 Plot3 ▙Y₁⊟(-X+3)/2 \Y₂= \Y₃= \Y₄= \Y₅= \Y₆= \Y₇=	WINDOW Xmin=-10 Xmax=10 Xscl=1 Ymin=-10 Ymax=10 Yscl=1 Xres=1	

Similarly, the icons ▜ and ▙ will result in **any function** (not just lines) being shaded respectively above or below the graph.

Think of it this way:

　　　With ▜, **Y1=** ... effectively becomes **Y1≥** ..., and

　　　With ▙, **Y1=** ... effectively becomes **Y1≤** ...

Calculator Appendix K

Finding GCD(GCF) and LCM

The greatest common divisor, GCD, (also called the greatest common factor, GCF) of several numbers is the largest number that divides evenly into all the number. On the calculator, it is only possible to find the GCD of two numbers.

For example, The GCD of 36 and 24 is 12 since 12 is the largest number that divides evenly into both 36 and 24.
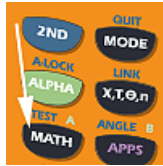
To find the GCD of 36 and 24, press the **MATH** button.
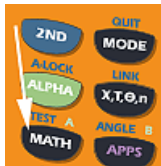
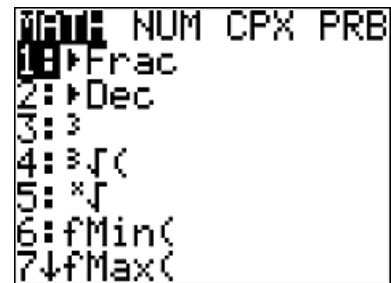Press the **RIGHT ARROW** to move to the **NUM** menu and then choose **9: gcd(**

Enter 36 and 24 separated by a comma and then a right parenthesis. Press **ENTER** to obtain the answer of 12.

The least common multiple, LCM, of several numbers is the smallest number into which all the numbers divide evenly. On the calculator, it is only possible to find the LCM of two numbers.
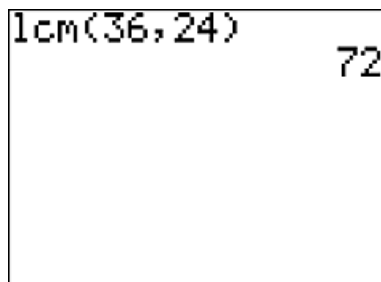
For example, he LCM of 36 and 24 is 72 since 72 is the smallest number into which both 36 and 24 divide evenly.

To find the LCM of 36 and 24, press the **MATH** button.

Press the **RIGHT ARROW** to move to the **NUM** menu and then choose **8: lcm(**

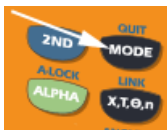Enter 36 and 24 separated by a comma and then a right parenthesis. Press **ENTER** to obtain the answer of 72.

Calculator Appendix L

Scientific Notation

A number in scientific notation is expressed as a number between 1 and 10 ($1 \leq n < 10$) times a power of 10.

For example, 345 in scientific notation is written as $3.45 \text{ X } 10^2$ while .0948 is written as $9.48 \text{ X } 10^{-2}$.

Using the **MODE** key, either the **NORMAL** or **SCI**entific notation mode can be selected. With the **NORMAL** mode selected, the following shows how to convert $3.45 \text{ X } 10^2$ to **NORMAL** mode, 345.
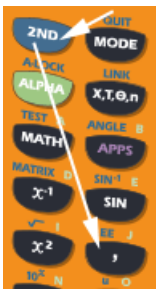
Enter $3.45 \text{ X } 10^2$ by first entering **3.45**. Press **2nd EE** to produce this result on the display. **E** indicates that whatever follows is to be the exponent of 10.

Now enter **2 (**the exponent of 10), and then press **ENTER**. The answer, 345, in **NORMA**L mode is displayed.
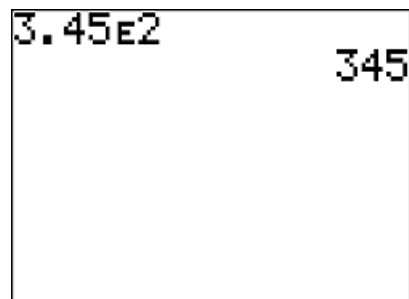
With the **SCI** mode selected, the following shows how to convert 345 to **SCI** mode, 3.45E2 (which means 3.45×10^2).

Enter **345** and then press **ENTER**. The equivalent of 345 in scientific notation, 3.45E2, is displayed.

When in the **SCI** mode, all results of calculations will be displayed in scientific notation as illustrated with this problem:

$3478\,(.052) + 3.788 = 1.84644 \times 10^2$

Calculator Appendix M

(Finding maximum and minimum points)

A **maximum point** of a function is a local point which has a greater value than all other points in its neighborhood. A function can have several maximums. A minimum point is similarly defined.

Consider the function y = -x^2 – 12x – 30. Our task is to find its single maximum. Obviously it's an "upside down" parabola and has a maximum point at the vertex of the parabola. Begin by pressing the **Y=** button and entering the function as **Y1**. Then press **GRAPH**.
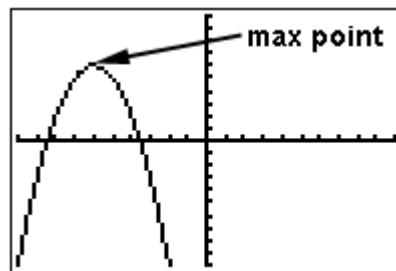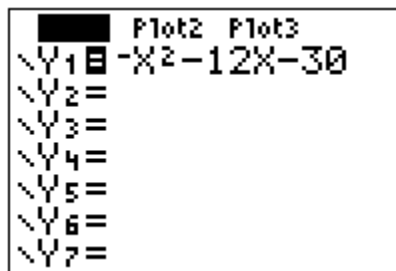
To initiate the process of finding the maximum point, press **2nd | CALC**. From the resulting menu choose **4: maximum** by pressing the **DOWN ARROW** button thus moving the cursor down to **4**: and then pressing **ENTER**, or by just pressing the **4** button.
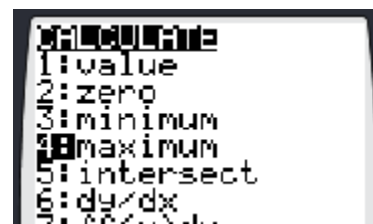

The instructions below will require moving the blinker with the **LEFT/RIGHT ARROWS**. Sometimes the blinker is not visible and it's not clear which way to move. Use the coordinates of the blinker at the bottom of the graph screen along with the zoom box coordinates to decide.
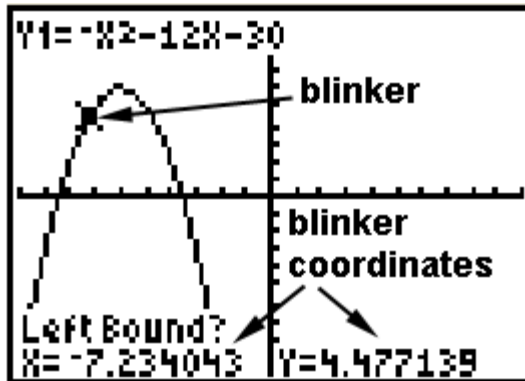
The next screen will show the graph along with a question, "Left Bound?". Move the blinker with the **LEFT/RIGHT ARROWS** until it is clearly to the left of the desired maximum point Press **ENTER** when satisfied with the position.

At this point another question will appear asking for the "Right Bound?". Move the blinker with the **LEFT/RIGHT ARROWS** until it is clearly to the right of the desired maximum point. Press **ENTER**.
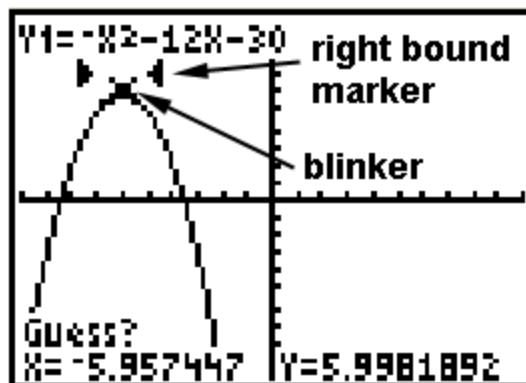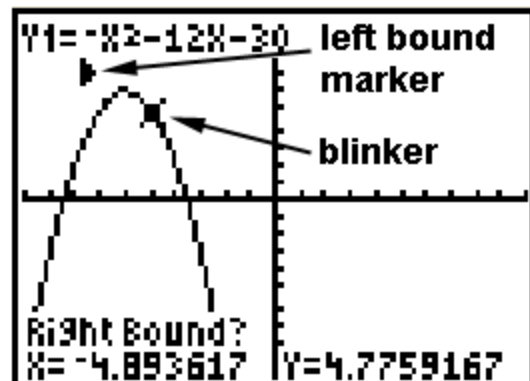
Finally, a third question is presented asking for a, "Guess?" Using the **LEFT/RIGHT ARROWS**, position the blinker approximately over the maximum point and press **ENTER**.

The coordinates of the maximum point are now presented at the bottom of the screen.

Minimum points are found in a similar fashion.
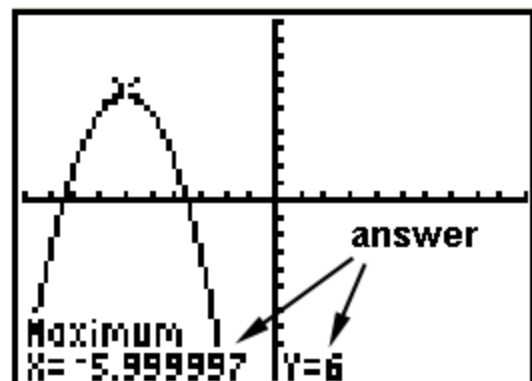
Calculator Appendix N

(Finding roots)

The root of a function is simply the *x* value of where it crosses the x-axis. It is possible for a function to have several roots.

Other names for **root** are **zero** and **x-intercept**. On a graphing calculator it is called a zero to emphasize that the value of the function is y = 0.

Consider the function $y = 3x^2 - 4x - 6$. Finding the roots of this function is equivalent to solving the equation $3x^2 - 4x - 6 = 0$.

Begin by pressing the **Y=** button and entering the function as **Y1**. Then press **GRAPH**.
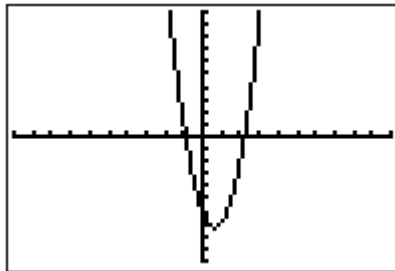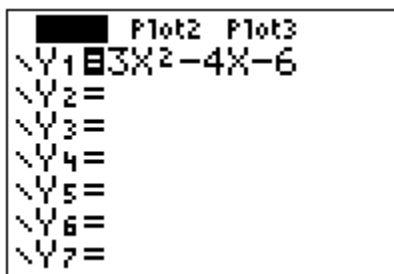
Clearly, from the graph there are two roots. We will concentrate on the left root.

To initiate the process of finding a root, press **2nd | CALC**. From the resulting menu choose **2: zero** by pressing the **DOWN ARROW** button thus moving the cursor down to **2:** and then pressing **ENTER**, or by just pressing the **2** button.
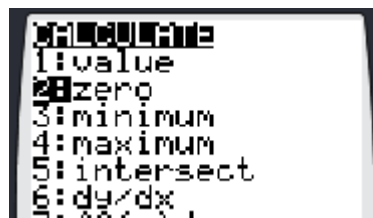
The next screen will show the graph along with a question, "Left Bound?". Move the blinker with the **LEFT/RIGHT ARROWS** until it is clearly to the left of the desired root (in this case, the left root). Press **ENTER** when satisfied with the position.
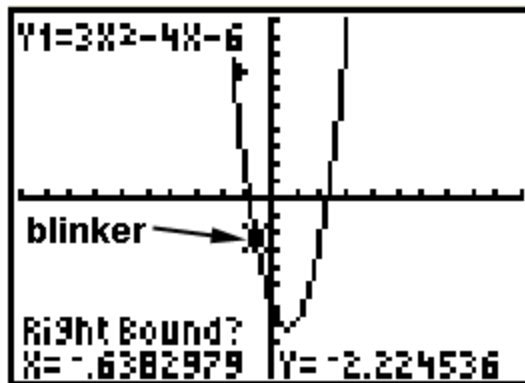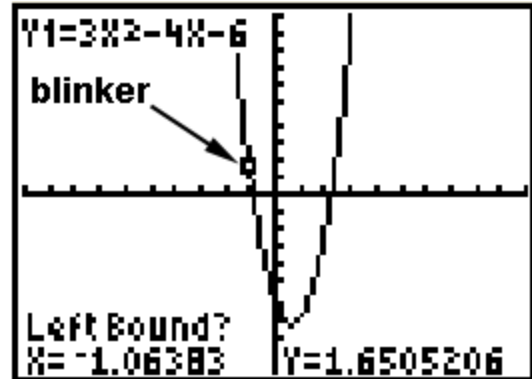
At this point another question will appear asking for the "Right Bound?". Move the blinker with the **LEFT/RIGHT ARROWS** until it is clearly to the right of the desired root. Press **ENTER**.

Finally, a third question is presented asking for a, "Guess?" Using the **LEFT/RIGHT ARROWS**, position the blinker approximately over the root and press **ENTER**.
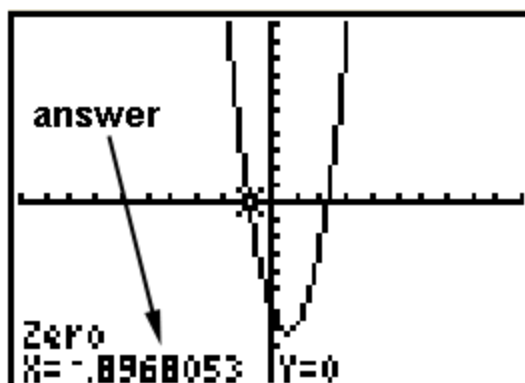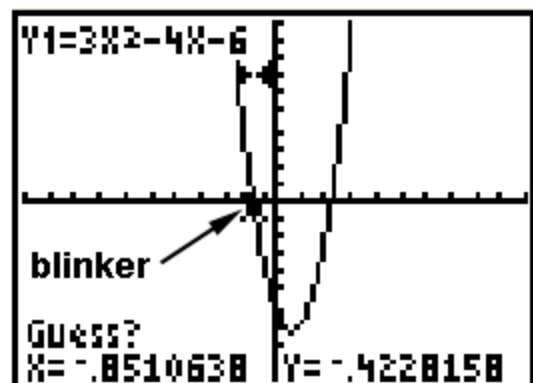
At this point the answer is presented at the bottom of the screen.

The other root is found in a similar fashion.
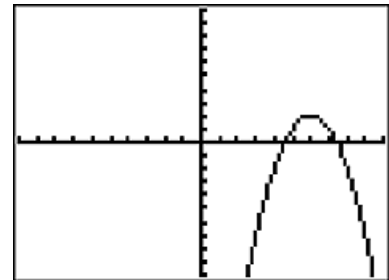
Calculator Appendix O

(Finding function values)

To find the value of a function at a particular value of *x*, first enter the function by pressing **Y=**. Then enter the function at Y1=. The example used here for **Y1** is -x^2 + 12x − 34.

```
Plot1  Plot2  Plot3
\Y1◻-X²+12X-34
\Y2=
\Y3=
\Y4=
\Y5=
\Y6=
\Y7=
```

Press **Graph** to display the graph of this parabola.

To evaluate this function at a particular value of *x*, press **2nd Calc**. and choose **1: value**.

```
CALCULATE
1◼value
2:zero
3:minimum
4:maximum
5:intersect
6:dy/dx
7:∫f(x)dx
```

Notice in the lower left corner of the resulting display, that we are invited to enter the *x*-value at which we wish to evaluate the function. For the sake of this demonstration, enter 3.

X=3
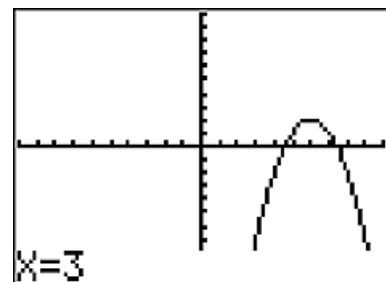
The answer we should get is f(3) = -(3)^2 + 12(3) − 34 = -7.

The resulting display shows the *y* value (the function value) is -7. As a bonus, the location of this point (3, -7) is marked on the graph of the function with a small x.
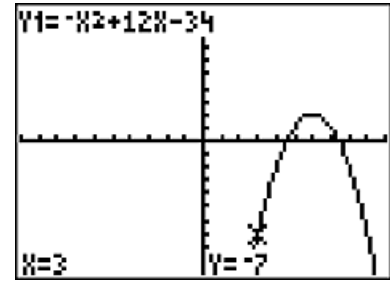
Beware of an error condition:

An error will result when trying to produce the value of a function if the position of that value on the graph of the function is not within the current window.

Calculator Appendix P
(Statistics)

Consider the following set of test grades:
{ 92, 99, 85, 95, 79, 64, 79, 91, 56, 82, 81 }

These numbers can be entered and the following statistics easily produced:

mean, median, standard deviation, lower-quartile, upper-quartile, min, max, … and more.

Press the **STAT** button and then select **EDIT** by pressing **ENTER**.

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

```
L1     L2     L3     2
92
99
85
95
79
64
79
L2(1)=
```

Under **L1**, enter the first number in the list, press the **DOWN ARROW**, and then enter the next number. Continue until all numbers are entered.(If **L1** is not initially empty, **UP ARROW** on top of **L1**, press **CLEAR** and then **ENTER**.)

Now that the data is entered we are ready to display statistical facts about the data:

Press the **STAT** button, **RIGHT ARROW** over to **CALC**.

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

Choose **1: 1-Var Stats**.
Press **ENTER** twice.

```
1-Var Stats
 x̄=82.09090909
 Σx=903
 Σx²=75795        mean
 Sx=12.91088336
 σx=12.31004428
↓n=11
            standard dev
```

The statistics for the data in the **L1** list displays. Use the **DOWN-ARROW** to move down the display to view the remaining statistics.

```
1-Var Stats
↑n=11
 minX=56
 Q₁=79 lower quartile
 Med=82 median
 Q₃=92 upper quartile
 maxX=99
```

The following definitions apply to the some of the displayed statistics:

The **mean** ($\bar{x}$) is the average:

The **median** (Med) is the number in the middle of the **ordered** list:
(If there are two numbers in the middle, average them.)

The **lower quartile** (Q_1) is the median of the lower half of the numbers:

The **upper quartile** (Q_3) is the median of the upper half of the numbers:
(When there are an odd number of data points, the middle value is not used when finding either quartile.)

The **standard deviation** (σ) is a measure of the average "scatter" of the data.

Calculator Appendix Q

Special marking of graphed functions
## Comparing lines and parabolas

Multiple functions can be simultaneously graphed by pressing the **Y=** button. Enter the first function beside **Y1=** and others beside **Y2=**, etc.

For the sake of illustration, the functions
$y = x$ and $y = 3x + 4$ are shown here.

After entering the functions, graph them by pressing the **GRAPH** button.
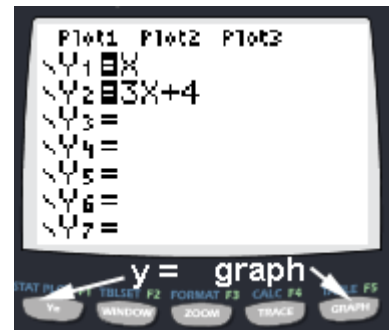
The two graphed functions will appear as shown here. (If not, press **ZOOM | 6: ZStandard** … the zoom button is the middle button in the picture above.)
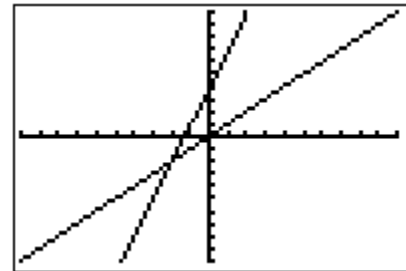
Although it is easy to tell which graph belongs to which function in this particular example, sometimes it is not this easy. This is especially true when there are several functions intertwined or when deep zooms allow only tiny portions to be viewed.

In the present example we will show how to **specially mark one of the functions** so there will be **no doubt concerning its identity** on the graph screen.

We will mark the steeper of the two lines (**Y2** = 3x + 4) by moving with the **UP** and/or **DOWN ARROWS** until the cursor is on the **Y2** function.

At this point we want to move the cursor to the left of **Y2**. Do this by pressing the **LEFT ARROW** twice. Press **ENTER** and the icon to the left of **Y2** will turn into a heavy mark. (Repeated pressing of **ENTER** will toggle through other options.)
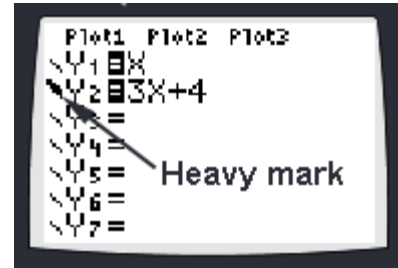
Now press the **GRAPH** button and the **Y2 function** will be observed to be displayed with a heavier graph so as to associate it with the proper function.
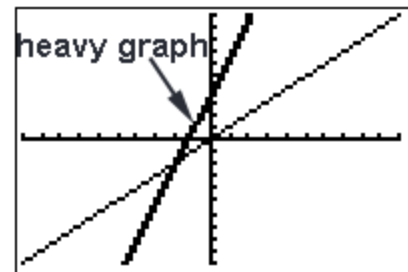
Similarly, two parabolas can be graphed and compared. For **Y1**, enter x^2 and for **Y2**, enter $.1(x + 5)^2 - 5$.

Mark the **Y2** function so it will display as a heavy graph as discussed above. Press the **GRAPH** button to produce the display shown here.
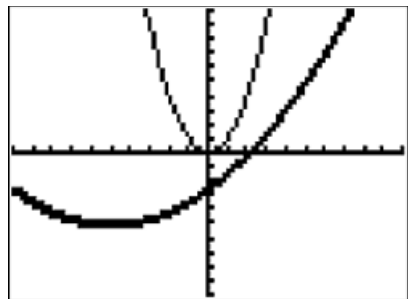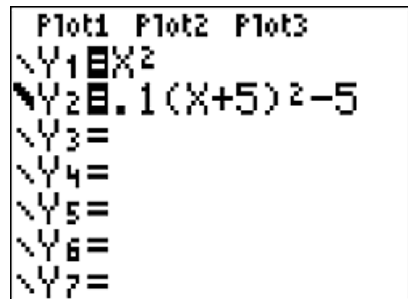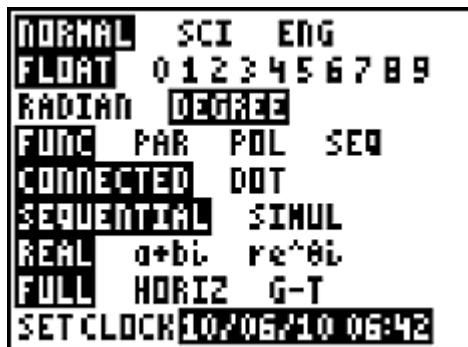
Calculator Appendix R

(Evaluation of trig expressions)

Changing Modes:

When doing angle conversions or evaluating trig expressions it is important to be in the correct angle mode (degree or radians). To verify which mode is currently set or to change the mode, press the **MODE** button.

In the adjacent picture notice that the angle mode is **DEGREE**. To change to **RADIAN** press the **DOWN ARROW** twice, and then **ENTER**.
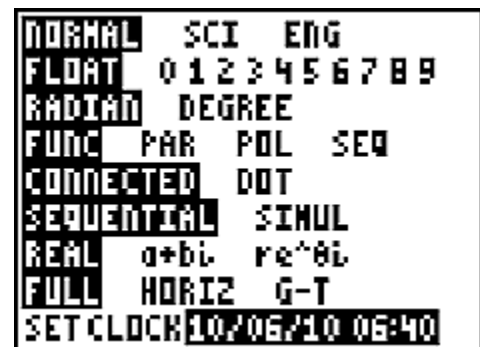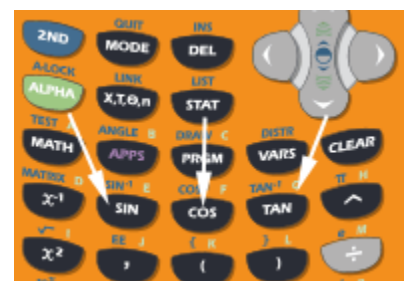
The result will be as shown here. The radian mode is now set. At this point pressing the **RIGHT ARROW** and then **ENTER** would cause the **DEGREE** mode to be set.

Only the three main trig functions (sin, cos, & tan) are directly available on a graphing calculator. To obtain the other three, use these identities:
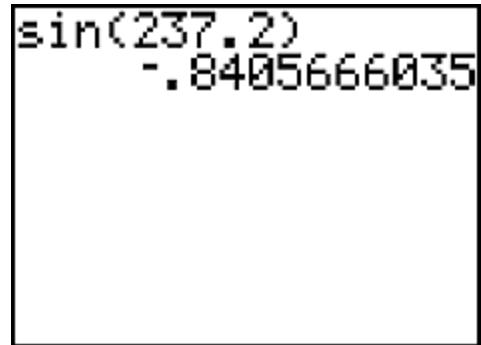
$$csc(\theta) = 1/sin(\theta)$$
$$sec(\theta) = 1/cos(\theta)$$
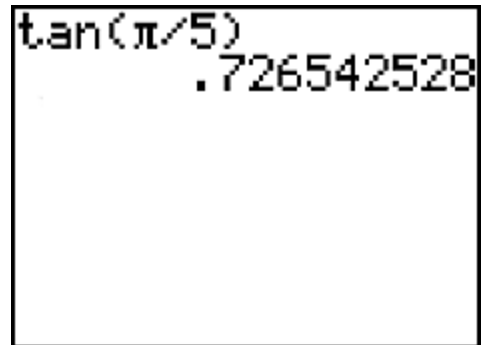$$cot(\theta) = 1/tan(\theta)$$

Example 1:

To find the sine of 237.2 degrees, use the **MODE** button to make sure the **DEGREE** mode is set. Then press the **SIN** button. The screen will now display **sin(** after which 237.2 can be entered. Close the parenthesis and press **ENTER**. The answer, −.8405666035, is displayed.
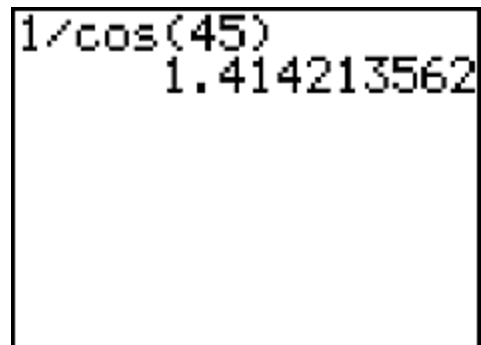
```
sin(237.2)
        -.8405666035
```

Example 2:

To find the tangent of π/5 radians, use the **MODE** button to make sure the **RADIAN** mode is set. Then press the **TAN** button. The screen will now display **tan(** after which π/5 can be entered. Close the parenthesis and press **ENTER**. The answer, .726542528, is displayed.

```
tan(π/5)
          .726542528
```

Example 3:

To find the secant of 45 degrees, use the **MODE** button to make sure the **DEGREE** mode is set. Using the identity sec(θ) = 1/cos(θ), enter **1/** and then press the **COS** button. The screen will now display **1/cos(** after which 45 can be entered. Close the parenthesis and press **ENTER**. The answer, 1.414213562, is displayed.

```
1/cos(45)
          1.414213562
```

Calculator Appendix S
Transformations
(Reflections and Rotations)

In this document, we will demonstrate how to draw a closed figure (such as a triangle) and then using lists **L₁, L₂, L₃**, etc. and the **STAT PLOT** button, how to perform various transformations such as a reflection and a rotation.

For both demonstrations, begin with a triangle having vertices at (1, 1), (7, 3), and (5, 6).

Press **STAT |1. Edit** and make these entries for **L₁** and **L₂**. Notice these are the coordinates of the vertices of the triangle mentioned above. Also, take special notice that the last point entered is the **same as the first point** so that the figure will be closed.

L1	L2	L3	2
1	1	------	
7	3		
5	6		
1	1		
------	▮		

L2(5) =

To display this triangle, press **2nd | STAT PLOT**.

```
STAT PLOTS
1▮Plot1…Off
   L1     L2      □
2:Plot2…Off
   L1     L2      □
3:Plot3…Off
   L1     L2      □
4↓PlotsOff
```
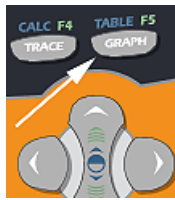
Choose **1. Plot1** to see its details. Make sure **Plot1** is turned **On** and that **Type** is set to the middle icon (Connected Graph). If **XList** and **YList** do not point respectively to **L₁** and **L₂** then press **2ⁿᵈ | List** to select the correct list.

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

Press **GRAPH** to view **Plot1**'s graph of the triangle. If your display does not look like this, press the **Zoom** button and choose **6. ZStandard**.
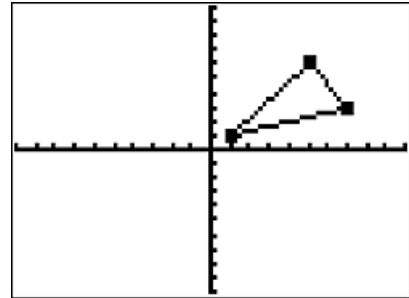
A reflection transformation:

The transformation that will reflect this object across the x-axis is (x, y) → (x, -y). To accomplish this, we will put the negative of the *y* coordinates (presently in **L1**) in **L3**, turn on **Plot2**, point its **XList** to **L1**, and point its **YList** to **L3**.

Press **Stat | Edit** and with the **Arrow** buttons move the cursor all the way to the top of the **L3** column and enter **(-) | 2ND | List** and choose **L2**. Notice **– L2** will now be displayed at the bottom of the screen as shown here.
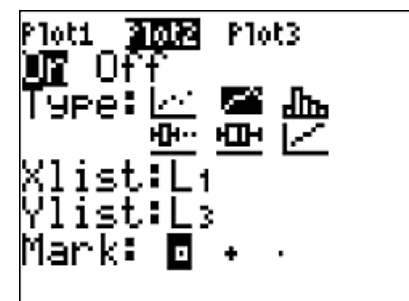
To populate the **L3** list, press the **Down Arrow** once. Notice that the entries are the negatives of the **L2** list as desired. This **L3** list will contain the new *y* values for **Plot2**.
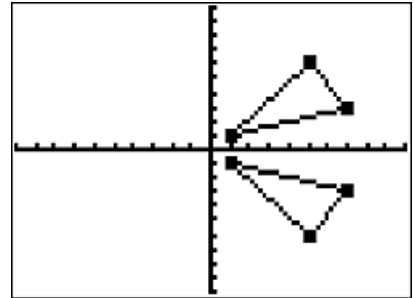
The next task is to turn on **Plot2** and to point **XList** and **Ylist** to the proper lists.

Press **2ND | STAT PLOT** and choose **2: Plot2**. Set the details of **Plot2** as shown here.

Press **GRAPH** and both **Plot1** and **Plot2** will display. Notice that **Plot2** is the reflection of **Plot1** across the x-axis thus implementing the transformation (x, y) → (x, -y).

Other reflection transformations are done similarly. For example, to reflect an object across the y-axis, implement the transformation (x, y) → (-x, y). To accomplish this, **L3** should be set to the negative of the values in **L1**. Then in **Plot2**, point **XList** to **L3** and **YList** to **L2**.

A rotation transformation:
The transformation for rotating 90° counterclockwise is (x, y) → (-y, x). Using the **L1** and **L2** list for the reflection example above we will need to set **L3** to **– L2** and then point **Plot2**'s **XList** to **L3** and **Ylist** to **L1**.
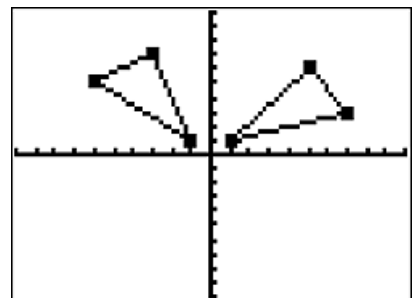
These tasks are all performed as described above in the reflection example. **L3** should now appear as shown here.

Turn on **Plot2** and set its details as shown here.

Press **GRAPH** to view **Plot2** rotated 90° from the position in **Plot1**.

Similarly, other rotations can be done by adjusting **L3** and **L4** and then pointing the **XList** and **YList** properties of **Plot2** to the appropriate lists. A few of the transformations that produce other rotations are:

- Rotate clockwise 90°: $(x, y) \rightarrow (y, -x)$

- Rotate clockwise 180°: $(x, y) \rightarrow (-x, -y)$

- Rotate clockwise 270°: $(x, y) \rightarrow (-y, x)$,