

Graphing Calculator Basics
Models TI-83, TI-83⁺, TI-84, and TI-84⁺
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Note: This is a handout on basic graphing calculator functions. Please refer to the assigned textbook sections for all calculator functions addressed in this class. **You will need to use the graphing calculator throughout this course.** You can also review the referred tutorials so that you learn more about using this important learning tool.

I. Basic functions

Display:

To darken or lighten screen, use $\boxed{2\text{nd}}$ $\boxed{\blacktriangle}$ or $\boxed{\blacktriangledown}$ arrows.

Erasing:

Delete \rightarrow Use $\boxed{\text{DEL}}$ to erase last entry

Clear \rightarrow Use $\boxed{\text{CLEAR}}$ to erase *all* entries

The two minuses:

Use $\boxed{-}$ (to the left of $\boxed{\text{ENTER}}$) for negative numbers

Use $\boxed{-}$ (right above the $\boxed{+}$ key) for minus or subtraction

Exponents:

Use the $\boxed{\wedge}$ (upper caret) symbol

Ex. $3^4 \rightarrow 3 \boxed{\wedge} 4$

The square key is given by default:

Ex. $3^2 \rightarrow 3 \boxed{x^2}$

The older models of the calculator will display a parenthesis, where you will type the exponent. The newer models will provide a box to input the exponent.

Roots:

Square root: $\boxed{\sqrt{}}$ will take the square root of a nonnegative number or expression.

Ex. $\sqrt{16} \rightarrow \boxed{2\text{nd}} \boxed{\sqrt{}} \boxed{16} \boxed{\text{ENTER}}$

The older models of the calculator will display a parenthesis; the newer models will provide a box to input the radicand (expression inside the radical symbol).

Note: If the expression is negative you will get an error message.

Other roots: The easiest way is to use the $(1/n)$ definition

Ex. Cube root of 8 $\rightarrow 8 \boxed{\wedge} (1/3)$

[Note: Use the division key $\boxed{\div}$ to type the fraction bar]

Fifth root of 1024 $\rightarrow 1024 \boxed{\wedge} (1/5)$

Changing screens:

2nd [QUIT] takes you back to the home screen.

(Note: [QUIT] is found above **MODE**)

Mode:

Use **FLOAT** to change the number of decimal places. Be sure to check your instructor's request on your tests; you may be asked to find the answer with 0 decimal places, or 2, 3, or 4, etc. To change it, just place the cursor on the desired number of decimal places and press **ENTER**. It is recommended to just highlight "Float" so that it displays the default number of decimal places; you can always round up as needed.



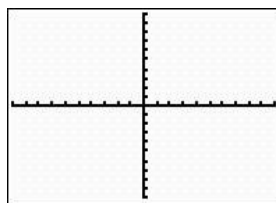
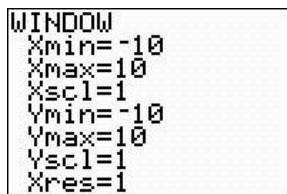
(The TI-83 has no "Set Clock" option)

II. Graphing

Viewing Window key: **WINDOW**

Tells us the portion of the coordinate system we are viewing when we look at our graph; change your window to see more -or less- of your graph.

Standard window (press **Zoom 6**): From -10 to 10 on both axes, with a scale of 1



Graphing Lines:

Example: Graph $y - 5 = 2x$

First, "y" must be isolated, so $y = 2x + 5$.

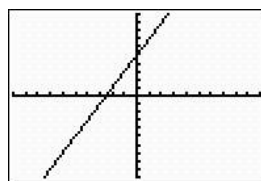
Go to **Y=** and type in the equation, then press **GRAPH**

Note: Use **X,T,θ,n** to type the "x" variable

```

Plot1 Plot2 Plot3
Y1=2X+5
Y2=
Y3=
Y4=
Y5=
Y6=
Y7=

```



[Important: If you see any “**Plot**” highlighted, move the cursor up to it and press **ENTER** to deactivate it; no “Plot” should be activated!] See screens below.

Correct

```

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

```

Incorrect

```

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

```

Example: Graph $y = \frac{1}{2}x - 6$

When entering fractions, always enclose them within parentheses!

This will help avoid unnecessary mistakes!

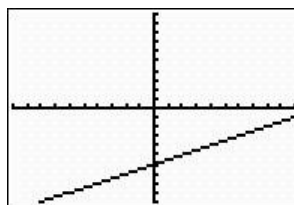
Go to **Y=** and enter $y = (1/2)x - 6$ then choose **GRAPH**

[Note: Use the division key \div to type the fraction bar]

```

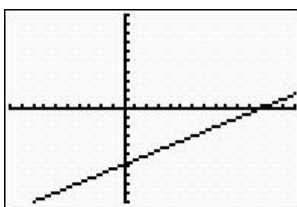
Plot1 Plot2 Plot3
Y1=(1/2)X-6
Y2=
Y3=
Y4=
Y5=
Y6=
Y7=

```



Notice that we cannot see the x -intercept! **An appropriate window for a line should always show both x -and- y intercepts.** The point where this line crosses the x -axis is beyond our standard viewing window (which gives us a maximum value of 10 for the x -axis). Therefore, we must assign a larger value to X_{\max} .

Press the **WINDOW** key and change X_{\max} to 15, or any larger value, until you clearly see the x -intercept.

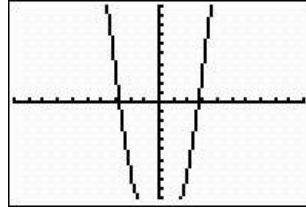


This is an appropriate window!

Quadratics:

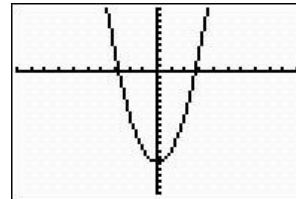
Example: $y = 2x^2 - 15$

Go to $\boxed{Y=}$ and enter the equation, then choose $\boxed{\text{GRAPH}}$



This is another case where the window must be expanded to accommodate the vertex (“turning point”) of this curve (*parabola*). The Ymin value of -20 (or other suitable) would give us a more appropriate viewing window:

```
WINDOW
Xmin=-10
Xmax=10
Xscl=1
Ymin=-20
Ymax=10
Yscl=1
Xres=1
```



Special Functions:

Ex. Absolute value function $y = |x| + 2$

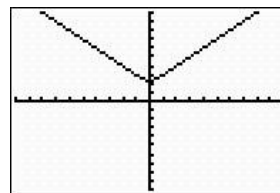
Go to $\boxed{Y=}$ and enter the equation into the calculator.

Note: To get the absolute value key, you can do one of the following:

- a) Go to $\boxed{\text{MATH}}$ \blacktriangleright NUM and choose option 1 *OR*
- b) Press $\boxed{2\text{nd}}$ $\boxed{\text{CATALOG}}$ and choose the first on the list
(You can find $\boxed{\text{CATALOG}}$ above the $\boxed{0}$ key.)

Graph (Press **Zoom 6** for the standard window)

```
Plot1 Plot2 Plot3
Y1=abs(X)+2
Y2=
Y3=
Y4=
Y5=
Y6=
Y7=
```



The older models of the calculator will display “abs” followed by a parenthesis; the newer models will provide the absolute value symbol: $| \quad |$

III. Intersections

Example: Find the intersection of the following lines

$$y = 3x - 2 \text{ and } x + 2y = 10$$

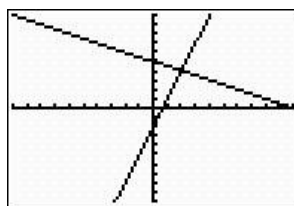
First, we need to isolate the “y” on the second equation.

You can isolate it as $y = -(1/2)x + 5$ or $y = \frac{10-x}{2}$

Important: Make sure to use parentheses when entering these expressions into the grapher. For the second option, you would need to enter it as $y = (10 - x) / 2$ so that the calculator divides the complete expression “10 – x” by 2.

The use of parentheses anytime you have a fraction will keep you out of trouble!

```
Plot1 Plot2 Plot3
Y1=3X-2
Y2=-(1/2)X+5
Y3=
Y4=
Y5=
Y6=
Y7=
```

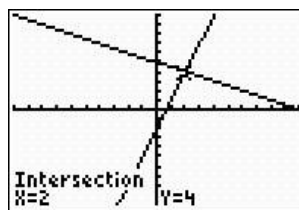


To find the intersection:

Press **[2nd]** **[CALC]** and choose option 5: **intersect** (Note: The **[CALC]** key is located above **[TRACE]**)

Select a first curve and press **[ENTER]**; select a second curve and press **[ENTER]**; find a guess and press **[ENTER]**.

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



Solution: $x = 2$ and $y = 4$ or the ordered pair $(2, 4)$.

(Important: When finding intersections, **do not** provide the values given just by tracing; they will not be correct! You need to use the "intersect" feature.)

Summary: Once you have the Y1 and the Y2 graphed, press **[2nd]** **[TRACE]** and choose option #5 ("intersect"); then press enter three times.

Example: Find the intersection:

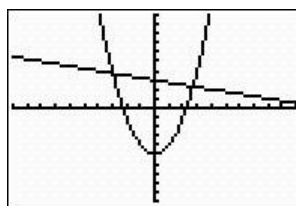
$$y = -0.25x + 3$$

$$y = x^2 - 5$$

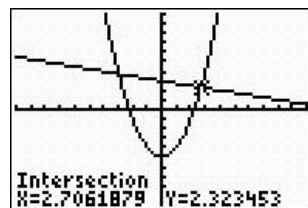
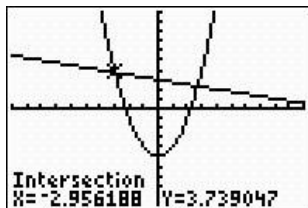
```

Plot1 Plot2 Plot3
Y1=-0.25X+3
Y2=X^2-5
Y3=
Y4=
Y5=
Y6=
Y7=

```



Since there are two points of intersection, you must find the intersection using the above procedure for each point. Select a first curve and press **ENTER**; select a second curve and press **ENTER**; find a guess and press **ENTER**. Repeat for the other point.



The calculator will find the first intersection automatically. You need to move the cursor with **TRACE** **◀** or **TRACE** **▶** to find the second point of intersection; repeat the process. The two intersection points (rounded to 3 decimal places) in our example are $(-2.956, 3.739)$ and $(2.706, 2.323)$.

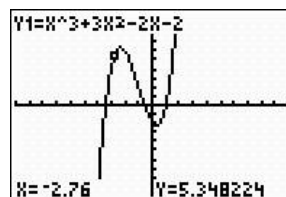
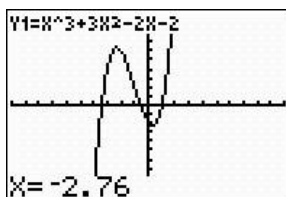
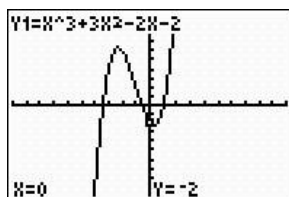
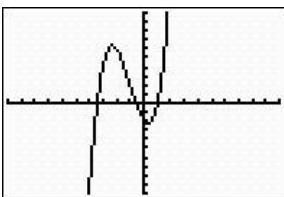
IV. Tracing versus finding values

Trace:

TRACE is useful in graph analyses. When tracing, the x -values are restricted to the interval $[Xmin, Xmax]$. For values outside of that interval you will have to change the window. The values obtained depend on the window used. You can use the left and right arrows to trace along a curve (or you can enter a value of x by hitting the **TRACE** key and then a numerical value). If you use the arrows to trace along the curve, the graph will be redrawn as you move beyond the set window and the window will change accordingly.

Example: Use your calculator to evaluate $y = x^3 + 3x^2 - 2x - 2$ at $x = -2.76$ by pressing **TRACE** and typing a value. Round your answer to 3 decimal places.

First, graph $y = x^3 + 3x^2 - 2x - 2$ in the standard window (that is, enter the function under Y1 and press Zoom 6); then press **TRACE**. You will see a value for x and y that depends on where the cursor is placed. Type the number -2.76 , press **ENTER** and you will get $y = 5.348$.



Value:

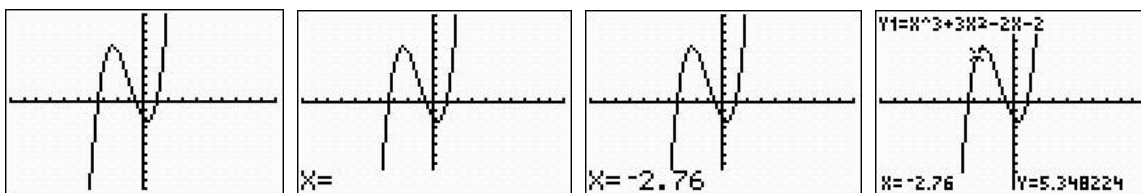
Press **2nd** [CALC] and choose option 1.

Value can be used to evaluate the function at any value within the range [Xmin, Xmax]. It performs similarly to the **TRACE** key when you enter a value. You can repeat the process by entering other values. If you enter a value that is outside the range, you will get an error message.

Example: Using your calculator, evaluate $y = x^3 + 3x^2 - 2x - 2$ at $x = -2.76$ by using the **value** feature of the calculator. Round your answer to 3 decimal places.

First, graph $y = x^3 + 3x^2 - 2x - 2$ in the standard window. To access the **value** feature, use the CALC function by pressing **2nd** [TRACE] and choosing option number 1 (type **1** or simply press **ENTER**).

Type $x = -2.76$, and press **ENTER**; you will get $y = 5.348$ after rounding.



V. Finding zeros (x-intercepts)

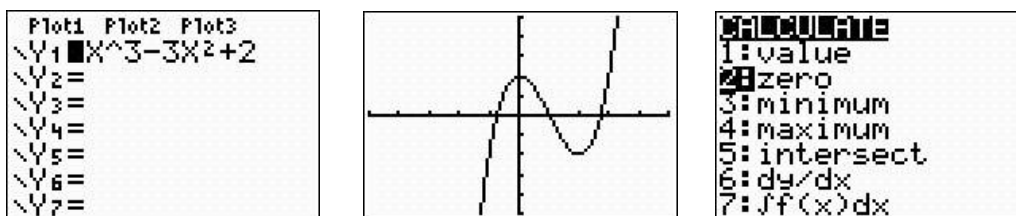
Press **2nd** [CALC] and choose option 2.

Zero can be used to find the x -value where a function's graph crosses the x -axis (in other words, the x -intercept). This is a very useful tool in solving equations. We can solve an equation by moving all the terms to one side of the equation (leaving 0 on the other); then we enter the nonzero side of the equation into the calculator using the **Y=** key. We find the x -intercept(s) of the graph by establishing a left bound and a right bound around the point on the x -axis (using the left and right arrows).

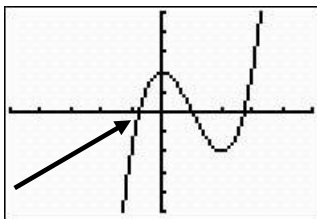
Example: Find the x -intercepts (or zeros) of $y = x^3 - 3x^2 + 2$

Graph $y = x^3 - 3x^2 + 2$ in the window $[-5, 5, -5, 5]$. That is, a minimum value of -5 for the x and y axes, and a maximum value of 5.

Press **2nd** [TRACE], and Press **2** to obtain the **zero** feature (it can also be obtained by using the **▼** to select option 2 and pressing **ENTER**.)



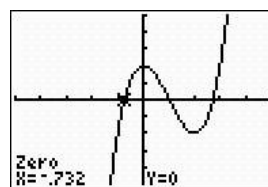
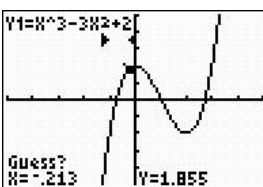
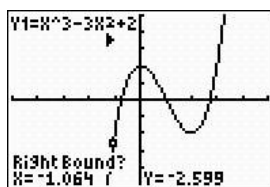
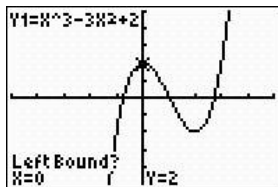
Since a graph may have more than one x -intercept, you must specify an interval containing the desired x -intercept. Let's say that we want to find the x -intercept to the left (see arrow).



When you select the **zero** option, the question "Left Bound?" appears at the bottom of the screen. Use the calculator arrows to move the blinking cursor to the *left* of the desired x -intercept, and press **ENTER**. See the first graph below.

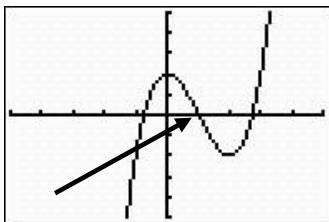
Next, the question "Right Bound?" appears at the bottom of the screen; use the **▶** again to move the blinking cursor to the *right* of the x -intercept, and press **ENTER**. See the second graph below.

When the calculator asks "Guess?" just press **ENTER** to get the x -intercept. See the sequence on the next graphs:

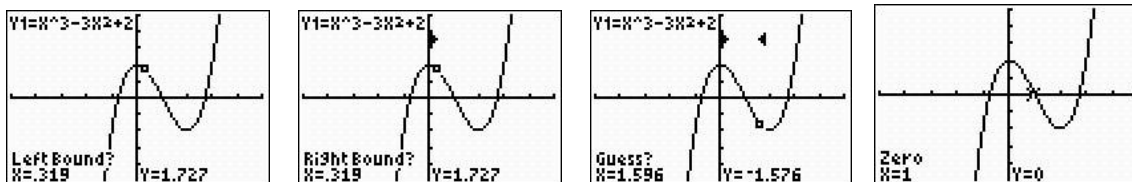


The coordinates of the x -intercept appear at the bottom of the last screen.

Let's find the second x -intercept using this **zero** function.



Remember: You need to establish the left and right boundaries, and when the calculator shows "guess" press **ENTER** to get the x -intercept. Follow the steps described previously. See the corresponding screens next:



The coordinates of the x -intercept appear at the bottom of the screen.

Now, you try to find the last x -intercept using the “**zero**” function.

You should get $x = 2.732$, $y = 0$.

VI. Maximum and minimum of graphs

To find Maximum and Minimum points on a graph, use the *maximum* and *minimum* options.

To find these points, use the CALCULATE feature by pressing **[2nd]** **[TRACE]** and choosing option number 3 for minimum, and option number 4 for maximum

```

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

```

```

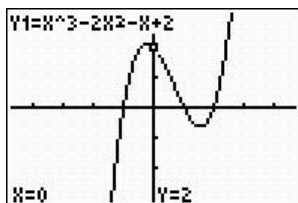
CALCULATE
1:value
2:zero
3:minimum
4:maximum
5:intersect
6:dy/dx
7:∫f(x)dx

```

Example: Find the *minimum* point of $y = x^3 - 2x^2 - x + 2$

Graph $y = x^3 - 2x^2 - x + 2$

Use **[ZOOM]** and select option 4 (“ZDecimal”) to have a better viewing window for this example.

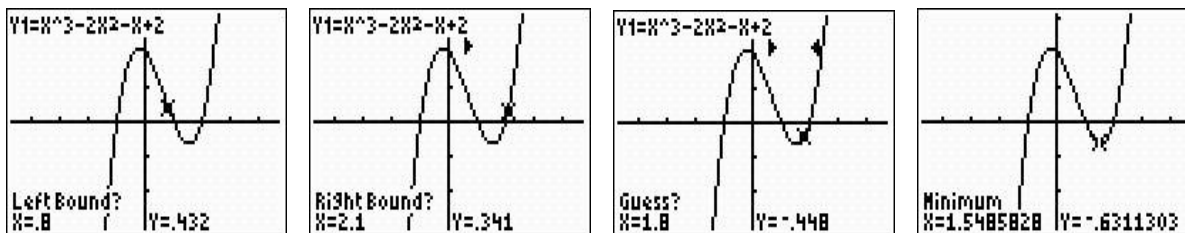


Press **[2nd]** **[TRACE]** and select option 3.

First, we need to specify an interval containing the desired high or low point on the graph by setting the bounds of the function. Since we wish to find the minimum, when the question "Left Bound?" appears at the bottom of the screen, use **[←]** to move the blinking cursor to the *left* of the relative minimum. Press **[ENTER]**. See the first screen below.

When the question "Right Bound?" appears at the bottom of the screen, press **[→]** to move the blinking cursor to the *right* of the relative minimum. Press **[ENTER]**. The arrows at the top of the screen indicate the boundaries between which the calculator will give the relative minimum. (The arrows must point toward each other.)

The question "Guess?" appears at the bottom of the screen; locate the cursor between the established boundaries and press **ENTER** to display the minimum value. See screens that follow.

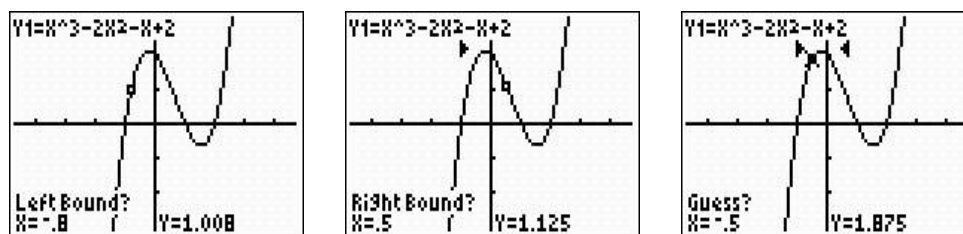


The coordinates of the minimum appear at the bottom of the screen.

Example: Find the *maximum* point of $y = x^3 - 2x^2 - x + 2$

Graph $y = x^3 - 2x^2 - x + 2$

Press **2nd** **TRACE** and select option 4, then follow the same steps as before to find a left bound, a right bound, and a guess:



You should get these values: $x = -.215$ and $y = 2.113$

VII. Solving equations graphically

a) The Intersection Method

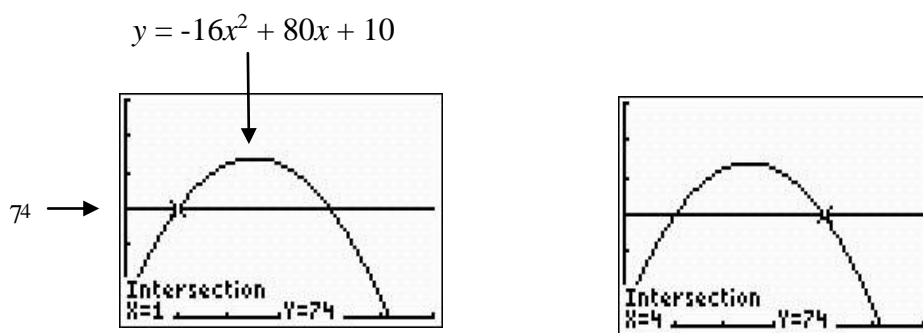
Example: Solve $-16x^2 + 80x + 10 = 74$ graphically for x .

If we apply the Intersection Method, we would enter

$$Y1 = -16x^2 + 80x + 10$$

$$Y2 = 74$$

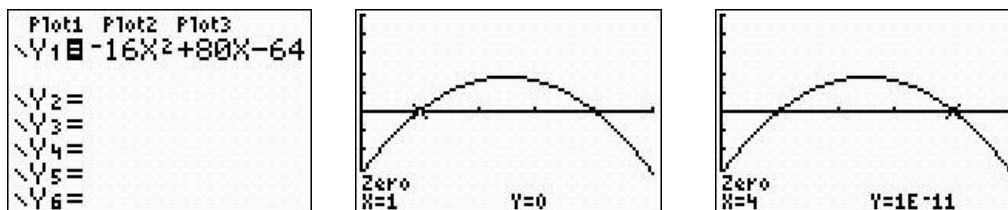
then find the intersection. See screens that follow.



b) The Intercept Method

Example: Solve $-16x^2 + 80x + 10 = 74$ graphically for x .

If we apply the Intercept Method, we first need to set the equation equal to zero:
 $-16x^2 + 80x - 64 = 0$. Then, we find the x intercepts.



The x intercepts are 1 and 4 (same we obtained using the Intersection method).

Note: $1E-11$ means $1 \times 10^{-11} = .00000000001$

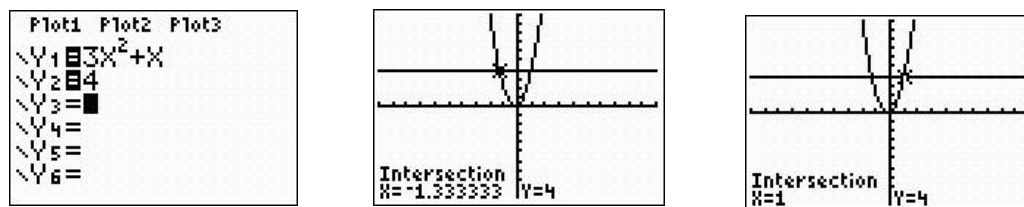
Notice that when using either the Intersection Method or the Intercept Method, the graphs are different, but we will obtain the same answer.

VIII. Solving inequalities graphically

a) The Intersection Method

Solve $3x^2 + x < 4$ graphically for x .

To solve an inequality graphically, first we solve the corresponding equation, and then interpret the graph. To solve the equation, use the intersection method.

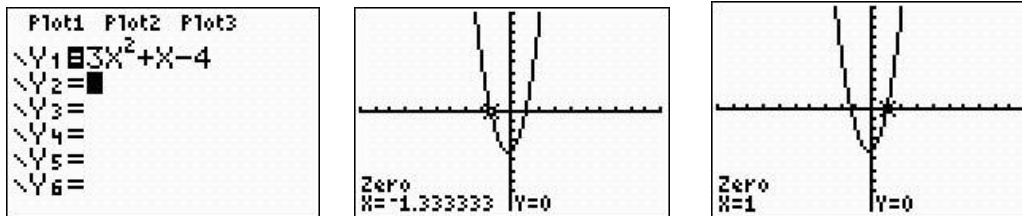


The intersections points are $(-1.33, 4)$ and $(1, 4)$. Now we interpret the graph to solve the inequality. The solution(s) of $3x^2 + x < 4$ are all the values of x where the parabola is below the line $y = 4$. Therefore, the solution is the interval $(-1.33, 1)$.

b) The Intercept Method

Solve $3x^2 + x < 4$ graphically for x .

To use the intercept method, we first solve the equation by moving all the terms to one side of the equation and zero on the other, $3x^2 + x - 4 = 0$. Then, we find the x -intercepts (with the **zero** feature).



The x -intercepts are -1.33 and 1. To solve the inequality, we now interpret the graph. The solution of $3x^2 + x - 4 < 0$ will consist of all the values of x where the parabola is below the x -axis, or the interval $(-1.33, 1)$. This is the same solution we obtained using the Intersection Method.