

## Graphing Calculator Basics TI-83, TI-83+, TI-84 and TI-84+

Note: This is a brief handout on basic graphing calculator functions. Click "Graphing Calculator Help" on your BB course page for tutorials on the features of the graphing calculator. **You will need to use the graphing calculator throughout this course.** It is important that you also review the referred tutorials so that you learn more about using this important 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.  $3^2 \rightarrow 3 \boxed{x^2}$

#### Roots:

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

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

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

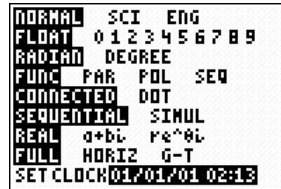
#### Changing screens:

$\boxed{2\text{nd}} \boxed{\text{QUIT}}$  takes you back to the home screen.

( $\boxed{\text{QUIT}}$  is found above  $\boxed{\text{MODE}}$ )

**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**.



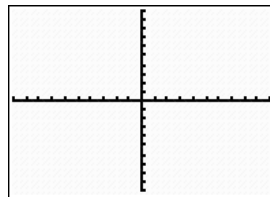
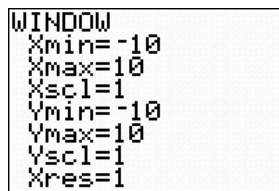
(The TI-83 does not show the “Set Clock” option)

**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 (Zoom 6): From -10 to 10 on both axes.



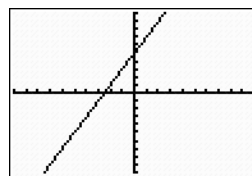
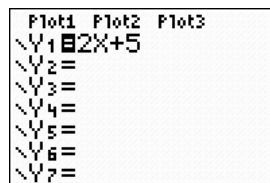
**Graphing Lines:**

Ex. Graph  $y - 5 = 2x$ .

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

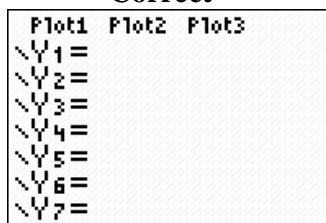
Go to **Y=** and type in the equation, then press **GRAPH**

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

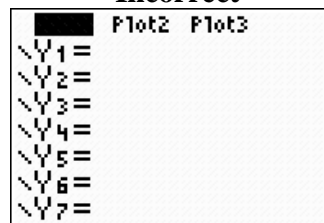


[Important! : If you see any “Plot” highlighted, move the cursor up to it and press **ENTER** to deactivate it; no “Plot” should be activated.]

### Correct



### Incorrect

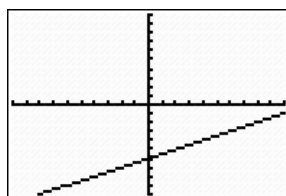
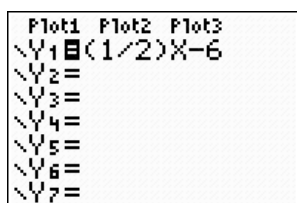


Ex.  $y = \frac{1}{2}x - 6$

When entering fractions, always enclose them within parentheses!

Go to  $\boxed{Y=}$  and enter  $y = \boxed{(} \boxed{1} \boxed{/} \boxed{2} \boxed{)} \boxed{x} - 6$  then choose  $\boxed{\text{GRAPH}}$

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

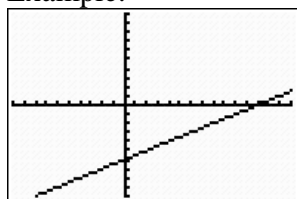


Notice that we cannot see the  $x$ -intercept! **An appropriate window for a line should always show both  $x$ -and- $y$  intercepts.** The point where this line crosses the  $x$ -axis is beyond our standard viewing window (which gives us a maximum value of 10 for the  $X$ -axis).

Therefore, we must assign a larger value to  $X_{\text{max}}$ .

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

Example:

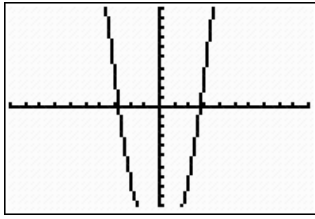


Appropriate window!

### Quadratics:

Ex.  $y = 2x^2 - 15$

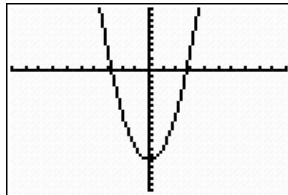
Go to  $\boxed{Y=}$  and enter the equation, then choose  $\boxed{\text{GRAPH}}$



This is another case where the window must be expanded to accommodate the vertex of this curve (*parabola*). The Ymin value of -20 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.

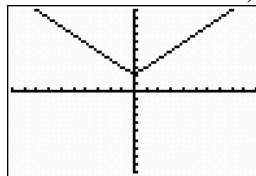
Note: To get the absolute value key, you can do one of the following:

- a) go to  $\boxed{\text{MATH}}$   $\boxed{\blacktriangleright}$  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=
  
```



**III. Intersections**

Ex. Find the intersection of the following lines  $y = 3x - 2$  and  $x + 2y = 10$ . Here we need to isolate

the “y” on the second equation. You can isolate it as

$$y = -\left(\frac{1}{2}\right)x + 5 \text{ or}$$

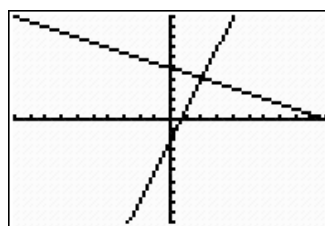
$$y = \frac{10 - x}{2} \text{ be sure to use parentheses when entering these expressions into the grapher.}$$

In this case, you would need to enter it as  $y = (10 - x) / 2$

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

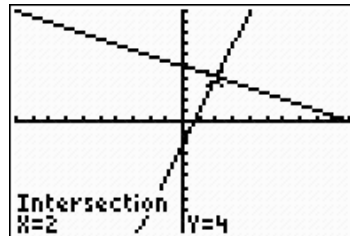
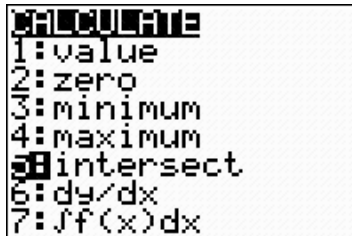
```

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



**To find the intersection:**

$\boxed{2\text{nd}}$   $\boxed{\text{CALC}}$  and choose option 5: intersect (Note: The  $\boxed{\text{CALC}}$  key is located above  $\boxed{\text{TRACE}}$ )  
 Select a first curve and press  $\boxed{\text{ENTER}}$ ; select a second curve and press  $\boxed{\text{ENTER}}$ ; find a guess and press  $\boxed{\text{ENTER}}$ .

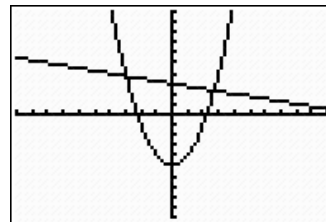
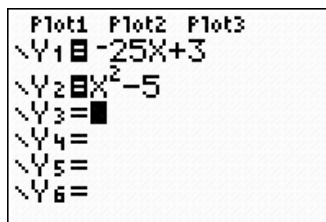


Solution:  $x = 2$  and  $y = 4$  or the ordered pair  $(2, 4)$

Another example: Find the intersection:

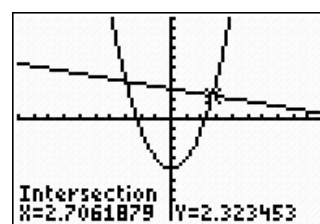
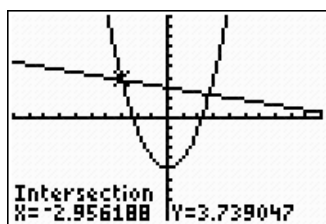
$$y = -.25x + 3$$

$$y = x^2 - 5$$



Since there are two points of intersection, you will have to find the intersection using the above procedure for each point.

Select a first curve and press  $\boxed{\text{ENTER}}$ ; select a second curve and press  $\boxed{\text{ENTER}}$ ; find a guess and press  $\boxed{\text{ENTER}}$ . Repeat for the right point.



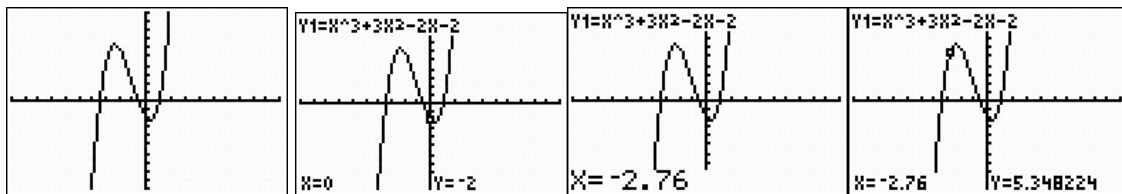
The calculator will find the first intersection automatically. You need to move the cursor with  $\boxed{\text{TRACE}}$   $\boxed{\leftarrow}$  to find the second point of intersection; repeat the process. The two intersection points (rounded to 3 decimal places) are  $(-2.956, 3.739)$  and  $(2.706, 2.323)$ .

#### 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. Ex. Use your calculator to evaluate  $y = x^3 + 3x^2 - 2x - 2$  at  $x = -2.76$  by pressing **TRACE** and typing a value. You must round your answer to three decimal places.

Graph  $y = x^3 + 3x^2 - 2x - 2$  in the standard window (that is, enter the function under Y1 and press zoom 6), and 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:

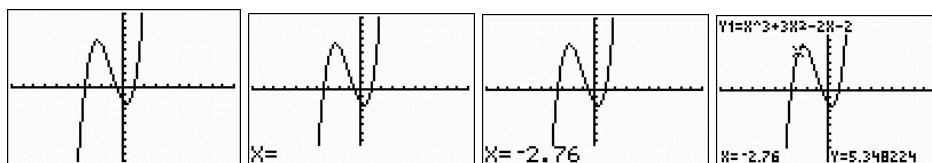
Press **2nd** **[CALC]** and choose option 1

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.

Ex. Using your calculator, evaluate  $y = x^3 + 3x^2 - 2x - 2$  at  $x = -2.76$  by using the *Value Option* of the calculator. You must round your answer to three decimal places.

Graph  $y = x^3 + 3x^2 - 2x - 2$  in the standard window. To access the value option, 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. Zero

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).

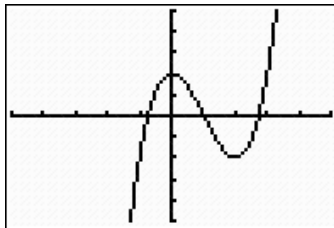
Ex. Find the x-intercepts (or zeros) of  $y = x^3 - 3x^2 + 2$

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** option (The **zero** option can also be obtained by using the **[↓]** to select option 2 and pressing **[ENTER]**.)

```

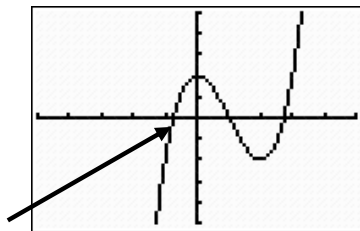
Plot1 Plot2 Plot3
Y1 X^3-3X^2+2
Y2 =
Y3 =
Y4 =
Y5 =
Y6 =
Y7 =
    
```



```

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

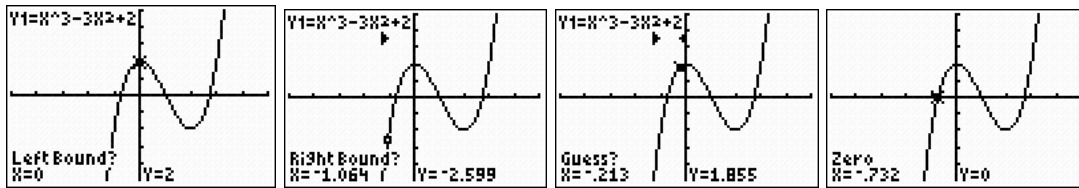
Since a graph may have more than one x -intercept, you must specify an interval containing the desired x intercept. Let's say that we want to find the x-intercept to the left (see arrow).



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.

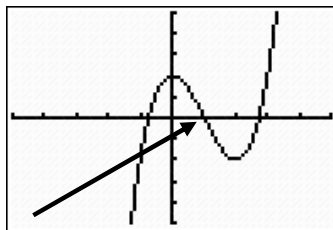
Now the question "Right Bound?" appears at the bottom of the screen; use the **[▶]** again to move the blinking cursor to the *right* of the x-intercept, and press **[ENTER]**. See the second graph below.

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

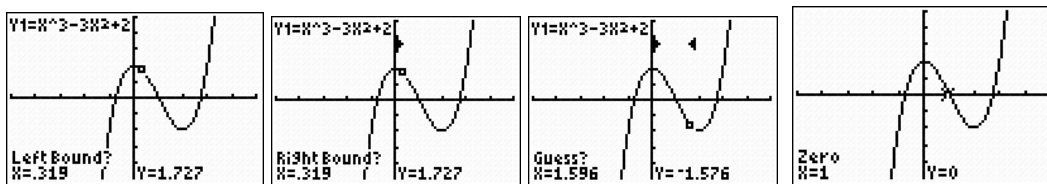


The coordinates of the x-intercept appear at the bottom of the last screen.

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



Remember: We need to establish the left and right boundaries, and when the calculator shows "guess" press **ENTER** to get the x-intercept. See the steps below:

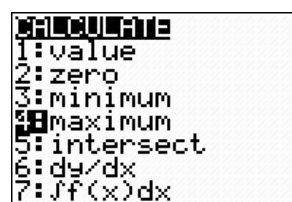
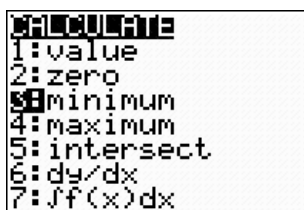


The coordinates of the x-intercept appear at the bottom of the screen.

Now, you try to find the last x-intercept using this "zero" function. You should get  $x = 2.732$ ,  $y = 0$ .

## VI. Maximum and minimum of graphs

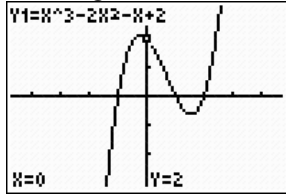
To find Maximum and Minimum points on a graph, use the *maximum* and *minimum* options. To find these points, use the CALCULATE feature by pressing **2nd** **TRACE** and choosing option number 3 for minimum, and option number 4 for maximum





Ex. 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).

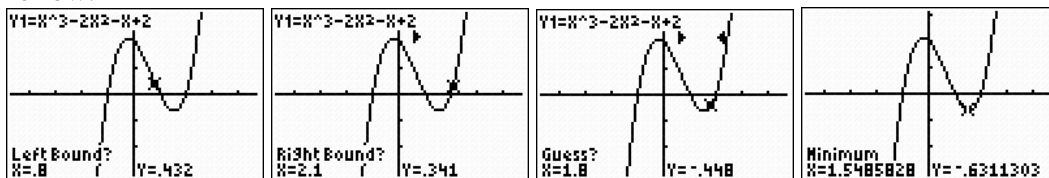


Press **2nd** **TRACE** and select option 3

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 on the following page.

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.

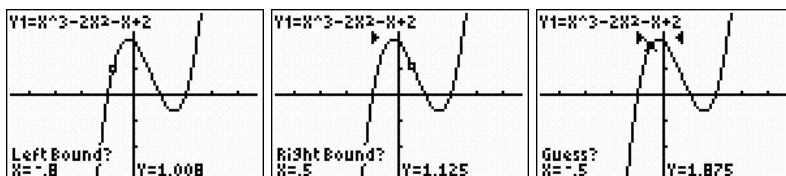


The coordinates of the minimum appear at the bottom of the screen.

Ex. 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:



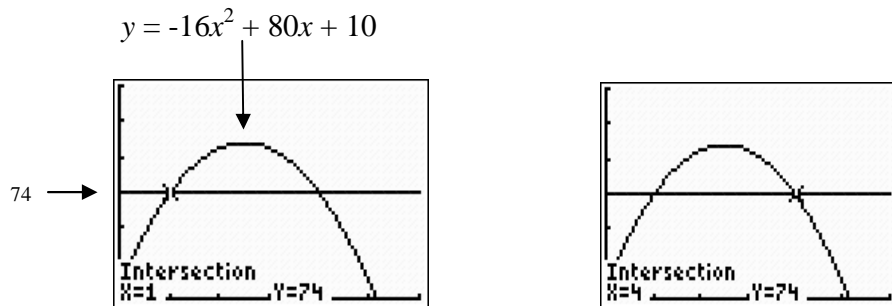
You should get the values  $x = -.215$  and  $y = 2.113$

## VII Solving Equations Graphically

### a) The Intersection Method

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

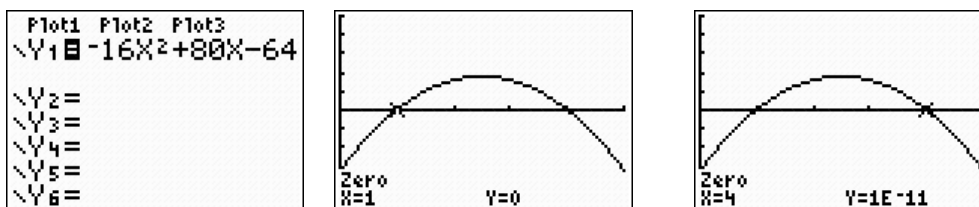
If we apply the Intersection Method, we would enter  $Y1 = -16x^2 + 80x + 10$  and  $Y2 = 74$ , and find the intersection.



### b) The Intercept Method

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

If we apply the Intercept Method, we would need to move all terms to one side of the equation;  $-16x^2 + 80x - 64 = 0$  and find the  $x$  intercepts.



The  $x$  intercepts are 1 and 4, as before.

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

Notice that when using either the Intersection Method or the Intercept Method, we obtain the same answer. The graphs are different, since we are finding the intersection when using one method and the intercept when using the other.

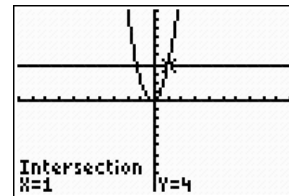
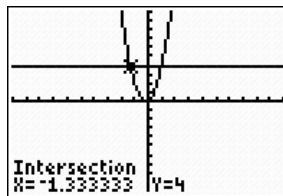
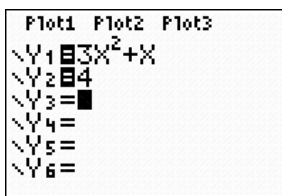
## VII Solving inequalities Graphically

### a) The intersection Method

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

To solve an inequality, first you need to solve the equation, and then interpret the graph

To solve the equation, use the intersection method.

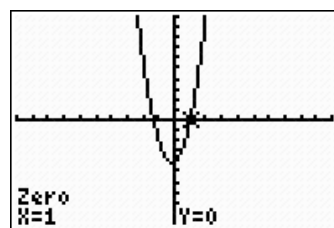
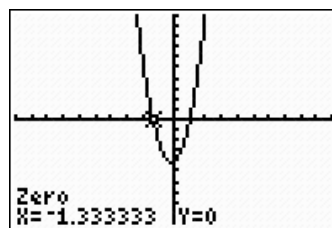
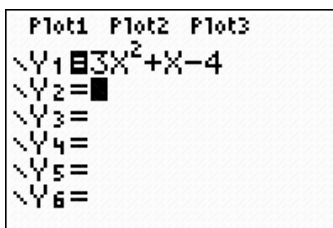


The intersections are the points  $(-1.33, 4)$  and  $(1, 4)$ . To solve the inequality you need to interpret the graph. The solution of  $3x^2 + x < 4$  are all the values of  $x$  below the line  $y = 4$  and the parabola, or the interval  $(-1.33, 1)$ .

### b) The Intercept Method

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

To use the intercept method, you need to first solve the equation by moving all the terms to one side of the equation,  $3x^2 + x - 4 = 0$ , and find the  $x$ -intercepts.



The  $x$  intercepts are  $-1.33$  and  $1$ . To solve the inequality you need to interpret the graph. The solution of  $3x^2 + x - 4 < 0$  are all the values of  $x$  below the  $x$ -axis, or the interval  $(-1.33, 1)$ , the same as the solution above.