Graphing Calculator Manual

College Algebra and Algebra and Trigonometry

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Table of Contents

The TI-82 and TI-83 Graphics Calculators

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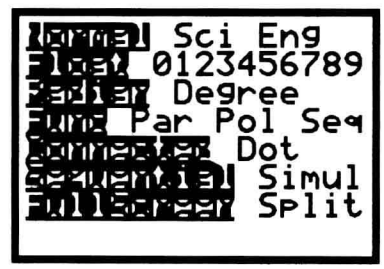
Preliminaries

Press [ON] to turn on the TI-82 or TI-83 graphing calculator. ([ON] is the key at the bottom left-hand corner of the keypad.) The display contrast can be adjusted by first pressing [2nd]. ([2nd] is the blue key on the TI-82 and the yellow key on the TI-83 in the left column of the keypad.) Then press and hold [△] to increase the contrast or [▽] to decrease the contrast. To turn the grapher off, press [2nd] [OFF]. (OFF is the second operation associated with the [ON] key.) The grapher will turn itself off automatically after about five minutes without any activity.

It will be helpful to read the Getting Started section of your grapher Guidebook before proceeding. See pages 1 - 14 of the TI-82 Guidebook or pages 1 - 18 of the TI-83 Guidebook.

Press [MODE] to display the MODE settings. Initially you should select the settings on the left side of the display.

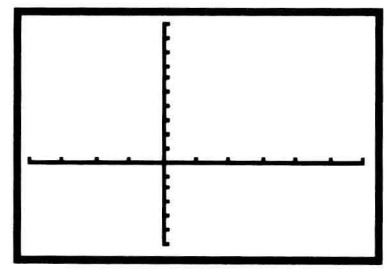


To change a setting use [▽] or [△] to move the cursor to the line of that setting. Then use [▷] or [◁] to move the blinking cursor to the desired setting and press [ENTER]. Press [CLEAR] or [2nd] [QUIT] to leave the MODE screen. (QUIT is the second operation associated with the [MODE] key.)

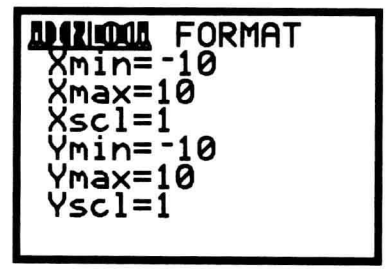
Chapter G
Introduction to Graphs and Graphers

SETTING THE VIEWING WINDOW

The viewing window is the portion of the coordinate plane that appears on the grapher's screen. It is defined by the minimum and maximum values of x and y: Xmin, Xmax, Ymin, and Ymax. The notation [Xmin, Xmax, Ymin, Ymax] is used in the text to represent these window settings or dimensions. For example, $[-12,\ 12,\ -8,\ 8]$ denotes a window that displays the portion of the x-axis from -12 to 12 and the portion of the y-axis from -8 to 8. In addition, the distance between tick marks on the axes is defined by the settings Xscl and Yscl. The TI-83 includes an additional setting, Xres, which sets the pixel resolution. We usually select Xres = 1. The window corresponding to the settings $[-20,\ 30,\ -12,\ 20]$, Xscl = 5, Yscl = 2, (Xres = 1), is shown below.



Press the [WINDOW] key on the top row of the keypad to display the current window settings on your grapher. The standard settings are shown below.



To change a setting press [▽] to move the cursor to the setting you wish to change and enter the new value. For example, to change from the standard settings to $[-20,\ 30,\ -12,\ 20]$, Xscl = 5, Yscl = 2, on the TI-82 press [▽] [(−)] 2 0 [ENTER] 3 0 [ENTER] 5 [ENTER] [(−)] 1 2 [ENTER] 2 0 [ENTER] 2 [ENTER]. You must use the gray [(−)] key on the bottom row of the keypad rather than the dark blue [−] key in the right-hand column to enter a negative number. [(−)] represents "the opposite of" or "the additive inverse of" whereas [−] is the subtraction key. The [▽] key may be used instead of [ENTER] after typing each window setting. On the TI-83, the cursor appears at Xmin after [WINDOW] is pressed, so the [▽] preceding −20 above should be omitted.

To return quickly to the standard window setting $[-10,\ 10,\ -10,\ 10]$, Xscl = 1, Yscl = 1, press [ZOOM] 6.

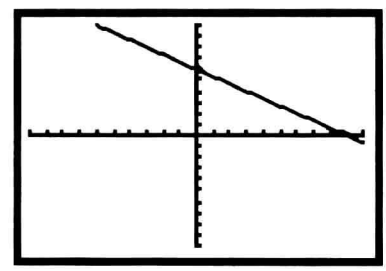
GRAPHING EQUATIONS

An equation must be solved for y before it can be graphed on the TI-82 and the TI-83.

Example 8 (a), page 8 (Page numbers refer to pages in the textbook.): To graph $2x + 3y = 18$, first solve for y, obtaining $y = \dfrac{18 - 2x}{3}$. Then press [Y =], the key at the top left-hand corner of the keypad. If there is currently an expression displayed for Y_1, press [CLEAR] to delete it. Do the same for expressions that appear on all other lines by using [▽] to move to a line and then pressing [CLEAR]. Then use [△] to move the cursor to the top line beside "Y_1 =." Now press [(] 18 [−] 2 [X, T, Θ] [)] [÷] 3 to enter the right-hand side of the equation. (The key that produces the X on the TI-83 is marked [X, T, Θ, n].) Note that without the parentheses the expression $18 - \dfrac{2x}{3}$ would have been entered.

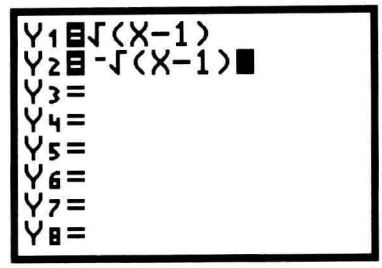
You can edit your entry if necessary. If, for instance, you pressed 5 instead of 8, use the [◁] key to move the cursor to 5 and then press 8 to overwrite it. If you forgot to type the right parenthesis, move the cursor to the division symbol /; then press [2nd] [INS] [)] to insert the parenthesis before the division symbol. ([INS] is the second operation associated with the [DEL] key.) You can continue to insert symbols immediately after the first insertion without pressing [2nd] [INS] again. If you typed 25 instead of 2, move the cursor to 5 and press [DEL]. This will delete the 5.

Once the equation is entered correctly, select a viewing window and then press [GRAPH] to display the graph. You may change the viewing window as desired to reveal more or less of the graph. The standard window is shown here.

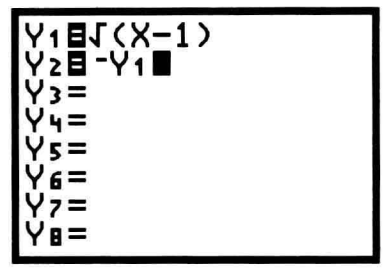


Example 8(c), page 8: To graph $x = y^2 + 1$, first solve the equation for y : $y = \pm\sqrt{x - 1}$. To obtain the entire graph of $x = y^2 + 1$, you must graph $y_1 = \sqrt{x - 1}$ and $y_2 = -\sqrt{x - 1}$ on the same screen. Press [Y =] and clear any expressions that currently appear. With the cursor beside "Y_1 =" press [2nd] [$\sqrt{\ }$] [(] [X, T, Θ] [−] 1 [)]. ([$\sqrt{\ }$] is the second operation associated with the [x^2] key.) Note that if the parentheses had not been used, the equation entered would have been $y_1 = \sqrt{x} - 1$. On the TI-83, the left parenthesis appears along with the radical symbol, so a separate keystroke is not necessary to introduce it.

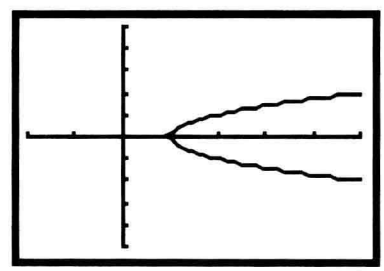
Now use [▽] to move the cursor beside "Y2 =." There are two ways to enter $y_2 = -\sqrt{x - 1}$. One is to enter the expression $-\sqrt{x - 1}$ directly by pressing [(−)] [2nd] [$\sqrt{\ }$] [(] [X, T, Θ] [−] 1 [)].



The other method of entering y_2 is based on the observation that $-\sqrt{x-1}$ is the opposite of the expression for y_1. That is, $y_2 = -y_1$. To enter this on the TI-82, place the cursor beside "Y2 =" and press (−) 2nd Y-VARS 1 1. (Y-VARS is the second operation associated with the VARS key.) This enters the opposite of y_1 as the expression for y_2. On the TI-83, press (−) VARS ▷ to select Y-Vars. Then press 1 1 to select y_1.



Select a viewing window and press GRAPH to display the graph. The window shown here is $[-2.5, -5, 5]$, Xscl = 1, Yscl = 1.



The top half is the graph of y_1, the bottom half is the graph of y_2, and together they yield the graph of $x = y^2 + 1$.

SQUARING THE VIEWING WINDOW

In the standard window, the distance between tick marks on the y-axis is about 2/3 the distance between tick marks on the x-axis. It is often desirable to choose window dimensions for which these distances are the same, creating a "square" window. Any window in which the ratio of the length of the y-axis to the length of the x-axis is 2/3 will produce this effect.

This can be accomplished by selecting dimensions for which Ymax − Ymin $= \frac{2}{3}$(Xmax − Xmin). For example, the windows $[-12, 12, -8, 8]$ and $[-6, 6, -4, 4]$ are square. To illustrate this, graph the circle $x^2 + y^2 = 49$ in the standard window by first entering $y_1 = \sqrt{49 - x^2}$ and $y_2 = -\sqrt{49 - x^2}$ or $y_2 = -y_1$. Note that x^2 can be entered either by pressing

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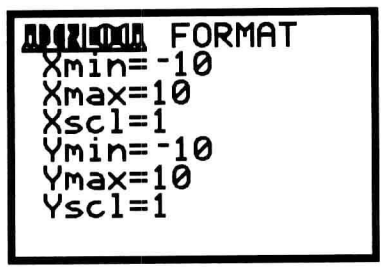
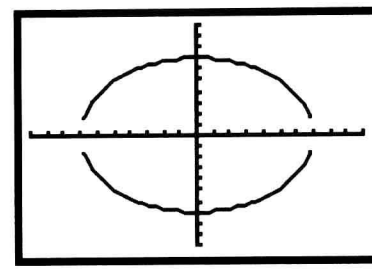
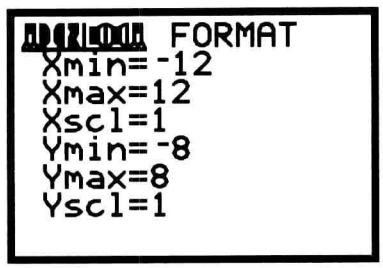
[X, T, Θ] [x^2] or by pressing [X, T, Θ] [∧] 2. The [∧] key can be used to enter any exponent, but for the exponent 2 the [x^2] key is more efficient. Select [ZOOM] 6 if the window settings are not already standard or press [GRAPH] if the standard settings have previously been entered.

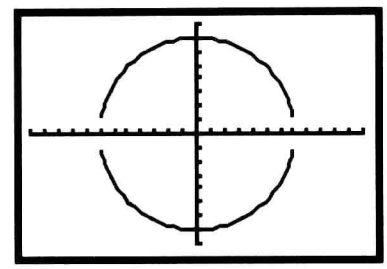




Note that the graph does not appear to be a circle.

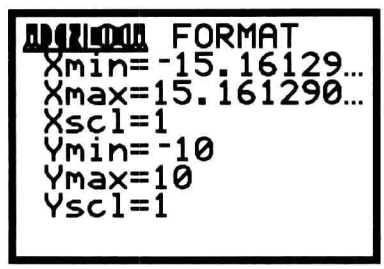
Now change the window dimensions to $[-12, 12, -8, 8]$, Xscl = 1, Yscl = 1, and press [GRAPH].

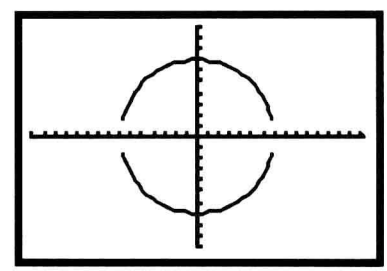




Observe that the distance between tick marks appears to be the same on both axes and that the graph appears to be a circle.

The window can also be squared using the grapher's ZSquare feature. Press [ZOOM] 6 to return to the graph of $x^2 + y^2 = 49$ in the standard window. Now press [ZOOM] 5 to select the ZSquare feature. The resulting window dimensions and graph are shown below. Note that the graph also appears to be a circle in this window.

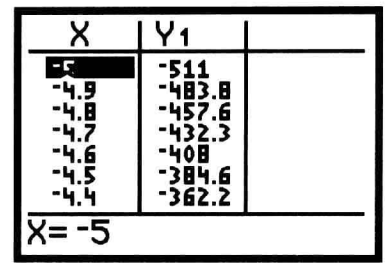




THE TABLE FEATURE

For an equation entered in the "Y =" screen, a table of x-and y-values can be displayed. For example, on the "Y =" screen enter $y_1 = 3x^3 - 5x^2 + 2x - 1$ by positioning the cursor beside "Y_1 =" and pressing 3 [X, T, Θ] [∧] 3 [−] 5 [X, T, Θ] [x^2] [+] 2 [X, T, Θ] [−] 1. Then press [2nd] [TblSet] to display the table set-up screen. (TblSet is the second function

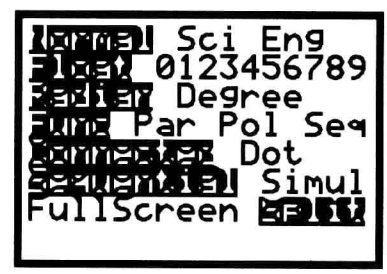
associated with the [WINDOW] key.) A minimum value of x can be chosen along with an increment for the x-values. Press -5 [▽] .1 to select a minimum x-value of -5 and an increment of 0.1. The "Indpnt" and "Depend" settings should both be "Auto." If either is not, use the [▽] key to position the blinking cursor over "Auto" on that line and then press [ENTER]. To display the table press [2nd] [TABLE]. (TABLE is the second function associated with the [GRAPH] key.)



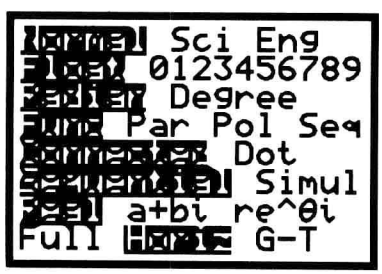
Use the [▽] and [△] keys to scroll through the table. For example, by using [▽] to scroll down we can see that $y_1 = -213$ when $x = -3.6$. Using [△] to scroll up, observe that $y_1 = -2530$ when $x = -8.9$.

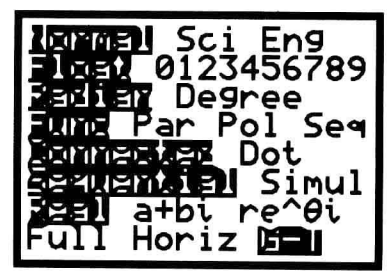
THE SPLIT SCREEN

A horizontally split screen can be used on both the TI-82 and the TI-83 to display the graph of an equation along with its corresponding table of values. The TI-83 will also display a graph and a table on a vertically split screen. To produce a split screen, we first use the MODE menu. For instance, for the table settings and the equation $y = 3x^3 - 5x^2 + 2x - 1$ entered as above, select a viewing window. Then on the TI-82 press [MODE] [▽] [▽] [▽] [▽] [▽] [▽] [▷] [ENTER]. This selects the split screen option.

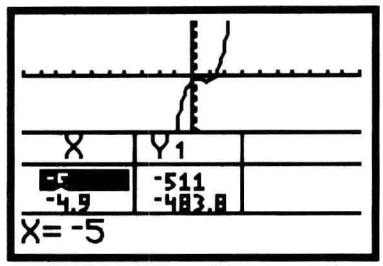


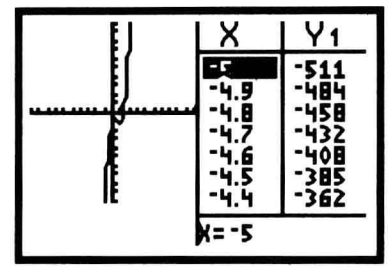
On the TI-83 press [MODE] [▽] [▽] [▽] [▽] [▽] [▽] [▽] [▷] [ENTER] to select a horizontally split screen or press [MODE] [▽] [▽] [▽] [▽] [▽] [▽] [▷] [▷] [ENTER] to select a vertically split screen.



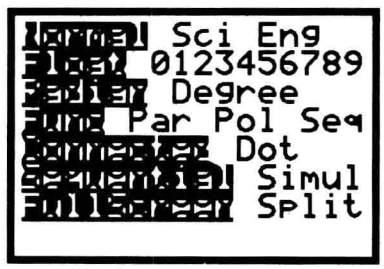


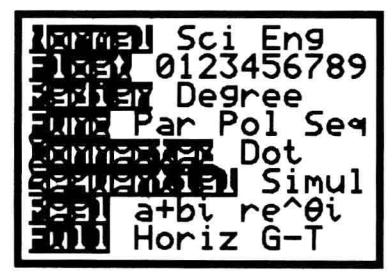
Now press [2nd] [TABLE]. In the horizontal mode the result is a split screen displaying the graph at the top with two rows of the table below it. In the vertical mode the graph is displayed on the left with seven rows of the table to its right. The [▽] and [△] keys can be used to scroll through the table as before.



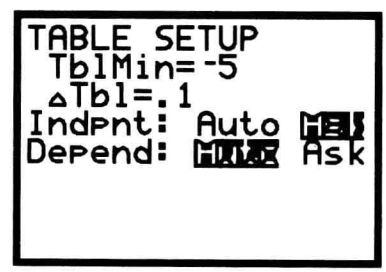


Return the TI-82 to full screen mode by pressing [MODE] [▽] [▽] [▽] [▽] [▽] [▽] [ENTER]. On the TI-83 press [MODE] [▽] [▽] [▽] [▽] [▽] [▽] [▽] [ENTER].

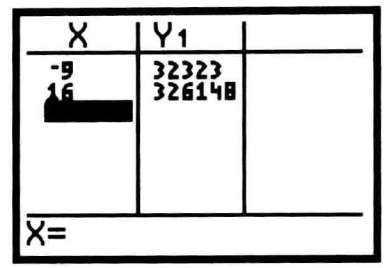




The TABLE feature can also be used to evaluate an expression. Enter $y_1 = 5x^4 - 6x^2 + 4$ in the "Y =" screen. Then press [2nd] [TblSet] [▽] [▽] [▷] [ENTER] to set the table in ASK mode. In ASK mode the grapher disregards the values of TblMin and Δ Tbl.



Press [2nd] [TABLE] and an empty table is displayed. Now x-values can be entered in the X-column and the corresponding y-values will be displayed in the Y_1-column. For example, when [(−)] 9 [ENTER] is pressed, -9 appears in the X-column and the grapher computes and enters 32323 in the Y_1-column. This is the value of $5x^4 - 6x^2 + 4$ when $x = -9$, or $5(-9)^4 - 6(-9)^2 + 4$. Press 16 [ENTER] and 326148 appears in the Y_1-column. This is the value of the expression when $x = 16$. You can continue to enter x-values as desired.

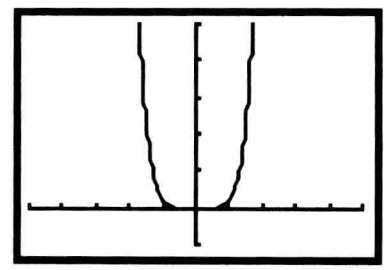


IDENTITIES

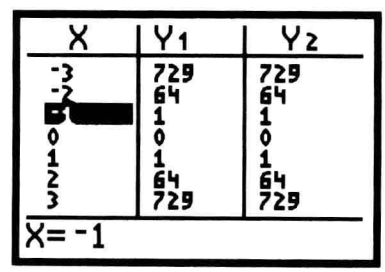
An equation that is true for every possible real-number substitution for the variable is an identity. The grapher can be used to provide a partial check whether an equation is an identity. Either a graph or a table can be used to do this.

Example 9 (a), page 11: Determine whether $(x^2)^3 = x^6$ appears to be an identity.

To determine whether this equation appears to be an identity, graph $y_1 = (x^2)^3$ and $y_2 = x^6$. Examine the graphs in several viewing windows. The graphs appear to coincide no matter what the window. Thus, although there is a possibility that the graphs fail to coincide outside the windows that were examined, the equation appears to be an identity.



A table will also confirm this. Scroll through a table of values for y_1 and y_2 and observe that y_1 and y_2 appear to have the same value for a given value of x. Again, although the y-values could differ for an x-value that was not observed, the equation appears to be an identity.

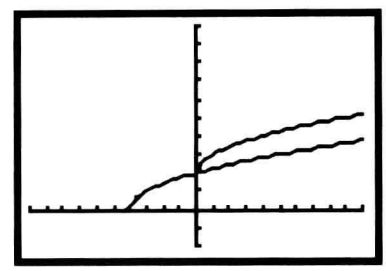


Example 9 (b), page 11: Determine whether $\sqrt{x+4} = \sqrt{x} + 2$ appears to be an identity.

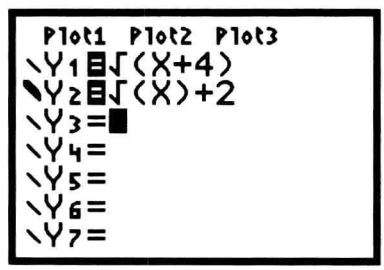
To determine whether this equation appears to be an identity, graph $y_1 = \sqrt{x+4}$ and $y_2 = \sqrt{x} + 2$. Note that parentheses must be used on the TI-82 when entering $\sqrt{x+4}$: [2nd] [$\sqrt{\ }$] [(] [X, T, Θ] [+] 4 [)]. Without parentheses the expression entered would be $\sqrt{x} + 4$. (Although the right parenthesis is optional, we include it for completeness.) The TI-83 forces

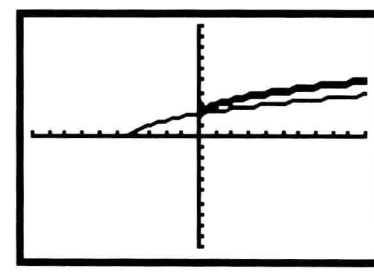
the use of parentheses by producing "$\sqrt{}$(" when [2nd] [$\sqrt{}$] is pressed and assumes a right parenthesis at the end of the expression if none is entered earlier. Thus, although it is not necessary to type parentheses when entering $\sqrt{x+4}$ on the TI-83, it is necessary to enter a right parenthesis in $y_2 = \sqrt{x} + 2$. Press [2nd] [$\sqrt{}$] [X, T, Θ] [)] [+] 2. If the right parenthesis is omitted, the expression becomes $\sqrt{x+2}$ rather than $\sqrt{x} + 2$.

Any window that includes a portion of the first quadrant will show that the graphs differ. Thus, the equation is not an identity.

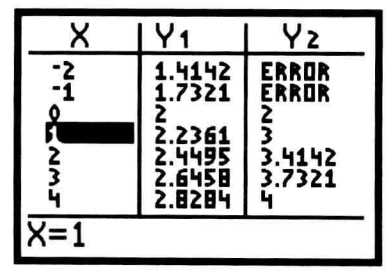


On the TI-83 different graph styles can be selected to allow us to differentiate visually between two or more graphs. Here, for example, we could have selected a solid line for y_1 and a dotted or thick line for y_2. Page 3-9 of the TI-83 Guidebook illustrates the available graph styles and their icons. The original settings of the TI-83 call for all equations to be graphed with a solid line. To change the style of a graph, begin by pressing [Y =] to display the "Y =" screen. To graph $y_2 = \sqrt{x}+2$ using a thick line, for example, we would first press [Y =]. Then press [▽] to move the cursor to y_2. Now press [◁] [◁] to move the cursor to the graph style icon in the far left-hand column beside y_2. Press [ENTER] repeatedly to rotate through the graph styles. These styles rotate in the same order in which they appear in the table on page 3-9 of the TI-83 Guidebook. When the thick line icon appears beside y_2, press [GRAPH] to display the graphs of y_1 and y_2.





A table will also show that y_1 and y_2 do not always have the same value for a given x-value.



Note that y_1 and y_2 have the same value for $x = 0$ but not for the other possible substitutions shown. (The ERROR entries in the Y_2-column show that $x = -2$ and $x = -1$ cannot be substituted in $\sqrt{x} + 2$ to obtain a real number.)

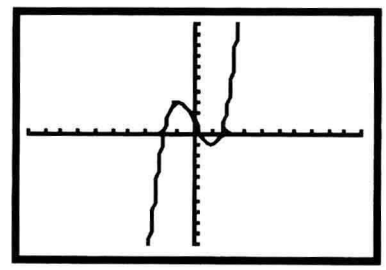
Both the graph and the table demonstrate that the equation is not an identity.

SOLVING EQUATIONS USING TRACE AND ZOOM

There are several techniques that can be used to solve equations with a grapher. One uses the grapher's TRACE and ZOOM features.

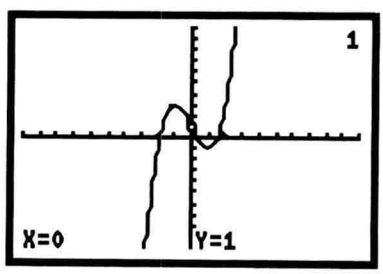
Example 10, page 13: Solve $x^3 - 3x + 1 = 0$. Approximate the solutions to three decimal places.

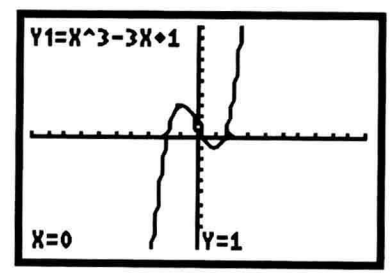
The solutions of this equation are the first coordinates of the x-intercepts of the graph of $y = x^3 - 3x + 1$. To find these coordinates we first graph $y = x^3 - 3x + 1$ in a viewing window that shows all of the x-intercepts. Here we use the standard window, $[-10, 10, -10, 10]$.



We see that x-intercepts occur near $x = -2$, $x = 0$, and $x = 2$. A portion of the viewing window can be enlarged near each of these values in order to find the desired three decimal place approximation. For example, let's examine the graph near $x = 0$.

Press [TRACE]. The TRACE cursor appears on the graph at the middle x-value of the window, in this case at $x = 0$. On the TI-82 the number 1 appears in the upper right-hand corner of the screen indicating that the cursor is on the graph of equation y_1. The equation of the curve being traced appears at the top of the screen on the TI-83. The x-and y-values at the bottom of the screen indicate the coordinates of the point where the cursor is positioned, in this case at $x = 0$, $y = 1$.





Pressing [◁] or [▷] moves the cursor to the left or right along the curve. Note that the TRACE cursor always remains on the curve.

In order to find the middle x-intercept, we enlarge the portion of the graph near $x = 0$ by first positioning the cursor

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