## Graphing Calculator "How To" Packe†

The following outlines some of the basic features of your TI Graphing Calculator. The graphing calculator is a useful tool that will be used extensively in this class and in your future math classes. Therefore, it is strongly recommended that you become very familiar with your calculator. In addition to this reference, you can find some online tutorials such as http://education.ti.com/studentzone/getahead/tutorials.html

Please keep this in your three-ring binder for the entire year

* Getting Home: If you want to get back to the home screen (the screen that appears when your calculator is initially turned on), type $2^{\text {nd }}$ MODE. Note that above the MODE key it says QUIT which is why this command brings you out of a screen and back home.
* Entering Negatives: Be sure to use the negative key (-) located in the bottom row next to the enter key rather than the subtraction key. For example, suppose you want to find 70 divided by -5 .

* Parentheses: Be sure to use () when entering fractions or negative numbers.
- ( is located above the 8 key
- ) is located above the 9 key
- Your calculator knows PEMDAS so be sure to enter expressions carefully. If you are performing a division, then put the entire numerator and the entire denominator in (). For example, entering 24/3*4 will output an answer of 32 whereas entering 24/(3*4) yields an answer of 2 as it does 24/12.
- Also, use () when using negatives. For example, if you enter $(-3)^{2}$ you will get an answer of 9 but if you enter $-3^{2}$ you will get an answer of -9 because your calculator will do the power (squaring) first and then take the opposite.


## Raising to a Power:

- To raise to a power use the carat key, $\wedge$, which is located in the far right column under the clear button. For example, to find $5^{3}$ you must type $5^{\wedge} 3$ then press enter to get 125 .
- To square a number you can use the carat key as above or you can also use the $x^{2}$ key which is located in center of the far left column. For example, to find $5^{2}$ you can type 5 then hit the $x^{2}$ key and enter.



## * Converting to Fractions:

- For example, suppose you have entered $3+\frac{4}{7}$ (of course, you would use parentheses) and your calculator displays an answer of $3.571428 \ldots$. If you hit MATH, select the first option of $>$ FRAC, and then enter you will pull up the command ANS $>$ FRAC and display 25/7.

- If a number is irrational then it can not be expressed as a fraction and thus this command will not yield a fraction. For example, if you enter $\sqrt{2}$ and then hit MATH FRAC it will output a decimal since $\sqrt{2}$ is irrational and therefore can NOT be converted to a fraction.
* Entering Square Roots: To enter a radical such as $\sqrt{49}$ enter $2^{\text {nd }}, x^{2}$ (Note above this key is the square root function and an open parentheses automatically appears), 49, and then close parenthesis and hit enter.
Try it and make sure you get an output of 7 .

* Entering Cube Roots: There are two ways to enter a cube root. Suppose you want to find $\sqrt[3]{8}$ you could do either of the following:
- MATH, select \#4 which says $\sqrt[3]{( }$, hit 8 , hit ), hit enter. Your calculator will output a 2 as expected since $2 * 2 * 2$ is 8 .
- $\sqrt[3]{8}$ is equivalent to $8^{\wedge}(1 / 3)$ so you can enter a cube root as raising to the one third. However, be sure to use parentheses as $8^{\wedge}(1 / 3)$ is very different than $8^{\wedge} 1 / 3$ since the later is 8 raised to the first and then divided by 3 .

* Entering Higher Roots: Similar to entering cube roots. Suppose you want to find $\sqrt[8]{92}$ you could do either of the following:
- Hit 8 , hit MATH and select $\# 5 \sqrt[x]{( }$, hit 9 , hit 2 , hit enter.
- Use the property that $\sqrt[n]{x}=x^{\left(\frac{1}{n}\right)}$ and enter $92^{\wedge}(1 / 8)$.

| $8 \times \sqrt{92}$ |
| ---: |
| $92 \times(1)$ |
| 1.75984119 |
| 1.75984119 |
|  |

* Pi: The $\pi$ key is located above the carat key. You should either leave your answers in terms of pi but if you need an approximation, use this key instead of 3.14 or $22 / 7$. Example: $5 \pi$ is approximated to the nearest hundredth as 15.71
* Absolute Value: The absolute value command is located under the MATH menu. Hit MATH and then arrow over to NUM and select $\# 1$ which states ABS.
Bbs(-3)
* Storing a Number: Suppose you have a number displayed on your calculator and you will want to use the exact number (not an approximation) in the future. This can be very helpful to check an answer or to solve for a constant. Suppose in solving the equation $2.2 x+3=8.1$, you end up with an answer of $2.31818 \ldots$. and you want to check it. You want to plug in the exact answer and see if the expression equals 8.1. You could turn the answer into a fraction (this is actually easiest) and use it to check or you could store it.
- With the decimal displayed, hit STO $\rightarrow$ (located above the ON button) and then pick a letter by hitting the ALPHA key and then the letter of your choice. For example, ALPHA 8 will select the letter $P$. Now hit enter and your calculator will again display the decimal. Now whenever you select the letter $P$ that decimal will be used until you store something else as $P$. To check the answer, if you enter $2.2 * \mathrm{P}+3$ the calculator gets 8.1 so the solution was correct.

* Recalling Previous Entry: This is very helpful if you entered a long expression and then noticed an error and want to make a slight change to it. Rather than then retype the entire expression you can just pull it back up.
- $2^{\text {nd }}$ Enter will pull up the last entry and you can use it repeatedly to pull up the second to last, third to last...etc.
- Once you have the entry pulled back up, then you can arrow through it and make changes. It may be necessary to use the insert command ( $2^{\text {nd }} \mathrm{DEL}$ ) so that you don't type over your entry.
- An example: You have used the quadratic formula to solve an equation and now you want to get approximate solutions. The two solutions are $\frac{\frac{5 \pm \sqrt{7}}{2}}{}$. In order to get approximate solutions, you need to enter the solutions separately. First you enter $(5+\sqrt{(7)}) / 2$ and you get an answer of $3.822 \ldots$. Now push $2^{\text {nd }}$ enter and your last command will appear and you can scroll to the left and change the + into -. Hit enter and you have an approximation for the other solution, $1.177 \ldots$
* Using Previous Answer: This is very helpful if you have entered an expression and now you want to perform another operation.
- $2^{\text {nd }}(-)$ will pull up your last answer (denoted ANS) so you can use to perform additional operations.
- Or you can just hit the key for your next operation. For example, suppose you enter 5+2*7 and your calculator has outputted 19 and now you want to multiply that by 3.12 you can just hit X 3.12 and your calculator will display ANS * 3.12 and yield 59.28
* Graphing: Suppose you want to view the graph of the line $y=\frac{1}{2} x+5$ on your calculator.
- First enter the equation. Hit $\mathrm{Y}=$ which is located top left and enter the equation $(1 \div 2) \mathrm{X}+5$. Note that X is located on the $\mathrm{X}, \mathrm{T}, \theta, n$ button which is below the MODE button and above the APPS button.

- Hit ZOOM (located in the center of the very top row) and select \#6 which is the

Zstandard. This standard window setting will set the window to display from -10 to 10 in both the x and y direction.

- Once the graph has been displayed, you can use TRACE to move along points on the line.

- Window settings: If you find it is necessary to change the window setting due to the fact that you can not fully see the graph, you can change the window by going to WINDOW and entering your desired mins and maxs.
- Xmin is where the $x$-axis begins on the left.
- Xmax is where the $x$-axis ends on the right.
- Xscl is the scale by which the x -axis is incremented.
- Ymin is where the $y$-axis begins at the bottom.
- Ymax is where the y-axis ends at the top.
- Yscl is the scale by which the $y$-axis is incremented.

For example, suppose you enter the curve $y=0.1 x^{2}+3 x+16$ and hit zoom6 you will not see the full parabolic curve but rather only part of the right branch of the parabola. The window needs to be adjusted to see more of the $x$-axis on the left and to see lower on the $y$ axis. If you change $\mathrm{X} \min$ to $-50, \mathrm{X} \max$ to 10 , Ymin to -20 , and Ymax to 50 then hit GRAPH (key is located far right of the very top row!, don't hit Zoom 6 to graph or you'll get standard window setting) you will see the parabola fully. You can also opt to change the scale since covering from -10 to -50 is wide range to go by units of one.

Zoom 6 graph


* Table: The table is useful to obtain a listing of coordinate points on the graph. Assume that you have an equation entered into $\mathrm{Y}=$. Let's use $y=0.1 x^{2}+3 x+16$
- Go to $2^{\text {nd }}$ Graph to access the table. You can scroll up and down to view (x,y) coordinates.

- To change the table setup, go to $2^{\text {nd }}$ Window (note TBLSET above the window button).
- TblStart $=$ is the number that the x column will begin with. You can change this. The $\Delta \mathrm{Tbl}=$ is the increments by which the table increases by. For example if you want the table to go up by units of five then set $\Delta \mathrm{Tbl}=5$.


- You can also change the independent variable (which is x) from Auto to Ask by arrowing down to the Indpnt row, arrow over to highlight Ask and hit enter so it stays highlighted. This allows you to ask about specific x values. Now if you go to the table it will be empty as it is waiting to be asked about certain $x$ values. If you hit 6.3 enter then you will see what y will be when x is 6.3 . You can also arrow over to the $y$-column to see the $y$-value displayed at the bottom of the screen which helps if it has been rounded. For example, when asked what $Y$ is when $x=2.995$, the chart rounds and displays three decimals but the entire number can be seen at the bottom.


* Entering a Data Set: We will often

| X | -5 | 3 | 7 | 9 |
| :--- | :--- | :--- | :--- | :--- |
| Y | 0 | 6 | 8 | 15 | enter data sets to run regressions (such as find the line of best fit) and to create visual displays such as box-and-whisker graphs. Suppose you want to enter the data set:

- Go to STAT (located in the center column under the DEL button) and select \#1 EDIT. Under L1 enter the x -values. Under L2 enter the y -values.
- If you want to clear all the entries from a list then arrow up so that the list number is highlighted and hit CLEAR (located in the far right column above the carat key) and then hit enter. All list entries will be cleared out. If you accidentally hit DEL instead of CLEAR then the entire list column will be deleted. To get it back, go to STAT and select \#5 SETUpEditor and hit enter. You will now get a DONE message on your home screen and all lists will be restored.
* Viewing a Data Set: To view a scatterplot of data, after you enter the data into L1 and L2 then you...
- Make sure that $\mathrm{Y}=$ is cleared out or that all equations' equal signs are un-highlighted as to not graph lines and curves over your data set.
- Go to StatPlots by selecting $2^{\text {nd }} \mathrm{Y}=$.
- Select PLOT1 and turn the plot ON.
- Select the type. The first option is the scatterplot.
- Xlist is where the $x$-data values are stored which is defaulted to L1. If necessary you can select a different list number by using $2^{\text {nd }}$ and then the appropriate number.
- Ylist is where the y-data values are stored which is defaulted to L2.
- Mark is how you would like the data points to be displayed.
- Adjust the window to fit the data. ZoomStat (option 9 under Zoom) will do this for you or consider the range of your variables. For example since the x -values range from -5 to 9 then a window setting of $\mathrm{Xmin}=-4$ and $\mathrm{Xmax}=10$ is sufficient.
- Select GRAPH to view the scatterplot.
- Once you are done with the scatterplot, you can quickly turn off your plots by going to $\mathrm{Y}=$ and scroll up to the PLOT1 and hit enter to un-highlight.

* Running Regressions: Consider the data in the previous example. Suppose you think that it looks linear. You can have your calculator find the equation of the line that best fits the data.
- Go to STAT, arrow over to CALC and select option \#4, LinReg. Note by default, L1 and L2 are used. If your data was in L3 and L4 then after pulling up the LinReg command to the home screen, you would enter $2^{\text {nd }} 3$ for L3, then a comma (above the " 7 "), and then $2^{\text {nd }}$ 4 for L4.
- Hit enter and your calculator will display the equation of the line of best fit. Note "a" is the slope and "b" is the y-intercept.
- If you do not get " $r$ " values, go to your catalog ( $2^{\text {nd }} Z \mathrm{Zero}$ ) and scroll down until you see "Diagnostic On". Hit enter to pull this to the home screen. Hit enter to run the command and now you will get a message that says "Done". Now if you run the regression again, you should get your "r" values.

- Note: We will run other regressions in addition to linear ones.
- A common error message "DIM MISMATCH". This means that your lists do not contain an equal number of data points. For every "x" there must be a " $y$ " so you missed have missed a data value. Figure out which one, highlight the entry below it and then hit $2^{\text {nd }}$ DEL which is the insert command. A " 0 " will be inserted which you can then change to the value you missed.
* Statistical Analysis of a Data Set: Suppose you have a list of numbers entered into a list. Let's put 3, $6,19,11,18,4$ into L1. Your calculator can analyze this data set.
- Go to STAT and arrow over to CALC. Select option \#1 and hit enter. This command will yield a statistical analysis of that one list. Note: L1 is used by default but you can specify another list by using $2^{\text {nd }} 2$ for L2, $2^{\text {nd }} 3$ for L3..etc.
- Several numbers are outputted and you can arrow down to see more. Some of these values will be useful if you ever take a stats class and others are described below.


$\rightarrow \quad \sum x$ is the sum of all the values
$\rightarrow \mathrm{n}$ is the number of entries in the data
- $\rightarrow \mathrm{Q} 1$ is the first quartile
$\rightarrow$ Med is the median $\rightarrow$ Q3 is the third quartile
$\rightarrow \operatorname{maxX}$ is the largest value
- Your graphing calculator can also rearrange a data set. For example, suppose you want to take the list you now have in L1 and put it in ascending order. Go to $2^{\text {nd }}$ STAT. Arrow over to OPS. Select option \#1 which says SortA. Now you have to enter the list number that you would like to order. Push $2^{\text {nd }} 1$ for L1. Close parenthesis. Hit enter and you will get a done message. Now if you go to STAT Edit and look at L1 you will find it in order!

* Solving an equation by graphing: Graphing can be used to determine a solution to an equation.

For example, suppose you want to solve $5.88 x-3.2=-2.1 x+9.9$.

- Enter one side of the equation in as Y1 and enter the other side of the equation in as Y2.
- Hit ZOOM 6 (the standard window setting) and see if you can see the point of intersection. If you can't see the intersection, then adjust your window.
- Select $2^{\text {nd }}$ TRACE (the calculate option) and then select \#5 for intersect.
- Using your right and left arrows, scroll so that you are near the point of intersection. (Note: If there are multiple solutions and multiple intersections then you have do find each one separately).
- Once you are near the intersection that you are finding, hit enter three times (the bottom will say first curve, second curve, guess), then your calculator will output an answer for the intersection. The x -value is the solution to the equation. The answer is $\mathrm{x}=1.641604 \ldots$.
- A cool feature....once you have solved for a value, it is now stored in your calculator as X. Hit $2^{\text {nd }}$ MODE to get to the home screen. Now select the variable key (X,T, $\theta, n$ ) and hit enter and you should get the solved for value displayed. Now you can turn that into a

655
fraction, provided of course that it is rational, and now we have the exact solution of 399 .


* Default Modes: As a default when you hit MODE, the options on the far left should be highlighted and when you hit $2^{\text {nd }}$ Zoom (Format), the options on the far left should be highlighted. If you play games on your calculator, these may get changed so be familiar with how to change them back to the default settings.

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- FLOAT means that decimals will be displayed to the screen's capacity. Suppose you change this to 3 , then decimals will only be shown to three places.
- RADIAN and DEGREE. This will get changed depending on the problem when you are doing trigonometry.
- CONNNECTED means that when graphing values are connected verses DOT when they are not. This will be helpful to change in chapter 4 when we are graphing rational functions and looking at asymptotes.
- SEQUENTIAL means that if you are graphing several functions (something in Y1, something else in Y2, ..etc), they will be graphed in sequential order verses SIMUL which means that they are graphed simultaneously.
- REAL means that the calculator will only give real answers. For example, in this mode if you enter $\sqrt{-4}$ you will get an error message. However if you switch your mode to $\mathrm{a}+\mathrm{bi}$, you will get the imaginary equivalent which is 2 i .
- FULL means that the full screen is used. HORIZ means that the graph is displayed (whatever you have in Y1) at the top and the bottom half of the screen can be used for calculations. G-T means that when you hit graph, the graph and table will both be displayed.
* Generating a Sequence: (This is not until chapter 13). Your calculator can generate the terms of a sequence. Let's say that you want to write out the first 10 terms of the sequence 2 n .
- Go to $2^{\text {nd }}$ STAT and arrow over to OPS. Select $\# 5$ for sequence. Now you have to enter the rule, then a comma, the variable (always X ), another comma, the starting term number, another comma, and the ending term number.
- If you want the first ten terms then 1 is the starting term number and 10 is the ending term number.
- Hit enter and the list will be generated. You can scroll to the right to see the enter list.
$\left.8^{824} 46,8,1610\right)$


## * Finding a Sum of a Sequence: (Not till CH 13)

- Go to $2^{\text {nd }}$ STAT, arrow over to MATH and select \#5 which says "sum(". Now you have to enter what you are taking the sum of which in this case is a sequence so enter the sequence as you did above. Now hit enter and you will get an answer of 110 because if you add up $2+4+6+\ldots 20$ it sums to 110 .

* Can't Find It? If you are having trouble locating a command, you can search for it in the catalog. To access the catalog, go to $2^{\text {nd }} 0$ (note: above the zero key you will find CATALOG).

