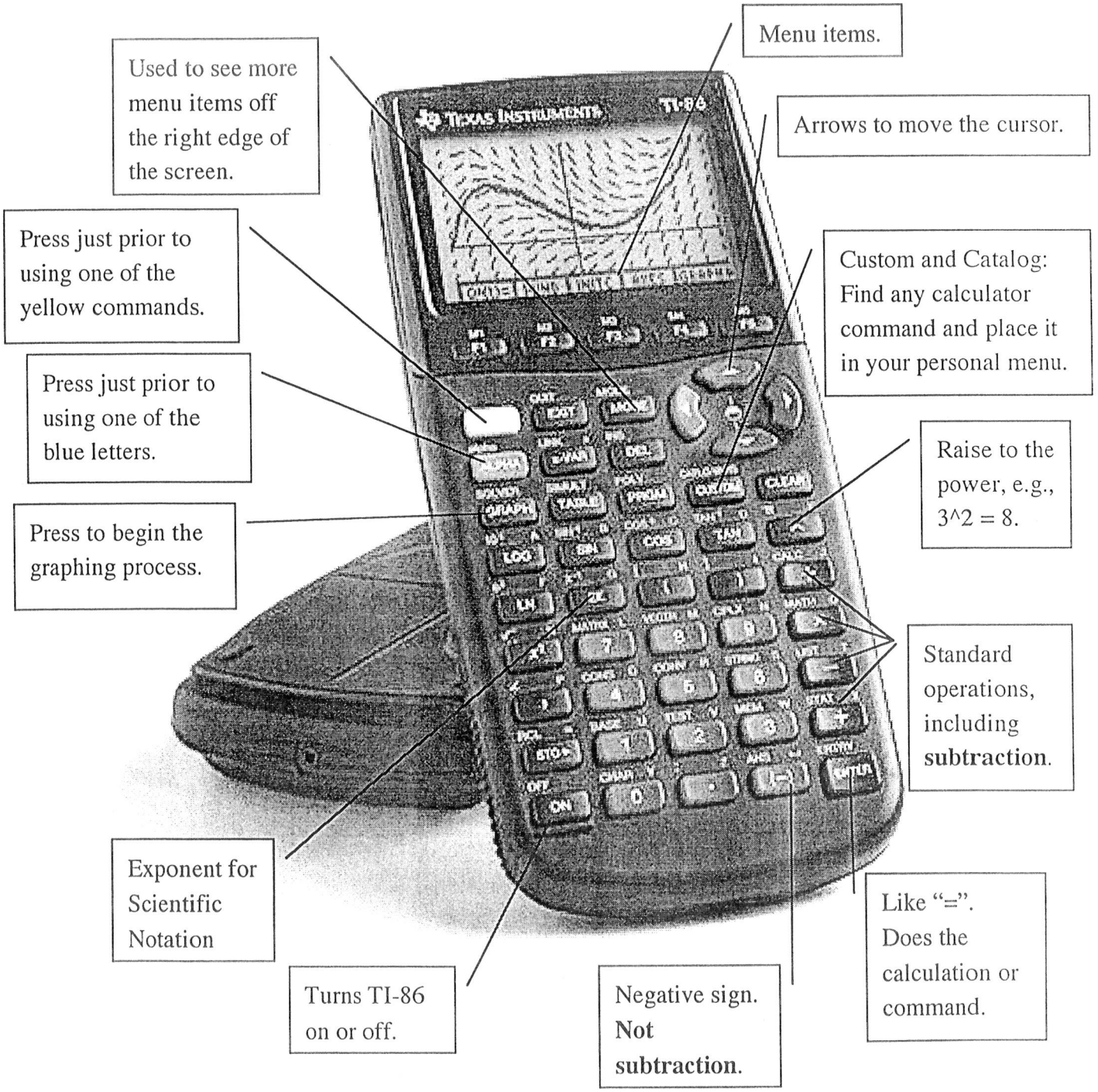
TI-86 Keystroke Guide

As an aid to learning how to use the graphing calculator most widely used in our department, we have written a series of short sets of instructions for the TI-86. You may use this as a way of either teaching yourself how to use different features of the calculator, or as a review of instructions covered in class. If you have any suggestions on how to make these instructions more clear, please pass them on to one of the faculty so that we may make learning how to use this important mathematical tool as efficient and painless as possible.

Table of Contents

General Calculator Operations

Below is a picture of the TI-86 with its associated buttons on the face of the calculator. Explore the buttons on your own calculator as you work your way around the calculator. In general, any given button can be used for three different commands: as the white lettering written on the button itself, as the yellow lettering in the upper left hand corner of each button, or as the blue lettering in the upper right hand corner of each button. The F1 - F5 and related M1 - M5 buttons represent the menu items that are on the screen.



Calculator Basics

1. Screen darkness level: When you turn on the calculator by pressing the **ON button**, the calculator may not show anything. To darken the screen, press the yellow 2^{nd} button and then press **the gray up arrow** key. Hold the up arrow key down until the screen gets as dark as you need. Watching the scale number in the upper right hand corner for the level of darkness. It ranges from 1 to 9.

2. Entering expressions: Type in the expression to be evaluated. For the most part, the calculator understands the proper format for the mathematical order of operations. Remember these are:
   a. Parenthesis
   b. Exponents
   c. Multiplication and Division, read left to right
   d. Addition and Subtraction, read left to right.

3. Special Considerations: There are some special formats that may look one way but are evaluated another. For example, when typing $\frac{1}{2x}$, it might look like 1/2x. But in fact the calculator will correctly interpret that expression as $\frac{1}{2}x$. To produce the effect you want, use parenthesis: 1/(2x).

4. Other special typing keys:
   a. To delete a character, place the cursor on top of the character using the gray arrow keys and then press **DEL** on the face of the calculator.
   b. To insert a character in an expression, place the cursor over a character and press 2^{nd} **INS** (look above the **DEL** key). The insert will appear to the left of the cursor.
   c. To reenter an expression, press 2^{nd} **ENTRY** (look above the **ENTER** button). This is helpful when you only want to change one character in a long expression and do not want to type the entire expression over. An example would be typing the positive part of the quadratic formula and then wishing to just change to the negative part without typing the expression all over again.
   d. To manipulate an answer, press 2^{nd} **ANS** (look above the (-), the negative sign) on the face of the calculator. This feature is convenient when you have calculated an expression and then, for example, want to take the square root of the answer. Rather than having to retype or insert the entire expression, just take the square root of the answer by pressing 2^{nd} $\sqrt{\ }$ followed by 2^{nd} **ANS**.

Customizing Your Favorite Menu Items

1. Calculator commands are found either on the face of the calculator or in menu items accessed through **F1-F5** and **M1-M5**. All commands are also listed in alphabetical order in the calculator catalogue. Frequently used commands can be placed in a "customized" menu list. We suggest that you at least have abs, eval, Frac, and $\sqrt[x]{}$ readily available in your custom menu items.

2. To customize an item, press **2nd CATLG-VARS** (look above the **CUSTOM** button) on the face of the calculator. Then press **CATLG** (F1) to find all the commands in the catalogue. The first one listed is **abs** (stands for absolute value). There is a pointer next to the item. To place the item in your customized list, press **CUSTM** (F3). You will see a tier of blank menu spots. Pick a place for **abs** by pressing an associated **F1-F5** button.

3. Place other favorite items in the custom section.
   a. **eval**, produces a y value for an x value. Press **EXIT** on the face of the calculator to eliminate the lower row. Press **E** (the ^ sign, with no **ALPHA** ahead of it), and then **PAGE ▼** to see **eval**. Use the gray arrows to place the pointer next to **eval** and press **CUSTM** and **F2** as before.
   b. **Frac**, changes a finite or repeating decimal into a fraction. Frac and other symbols are at the end.
   c. $\sqrt[x]{}$, a symbol that takes the xth root of a number.

4. To use these items, press **CUSTOM** on the face of the calculator and press a menu item of your choice.

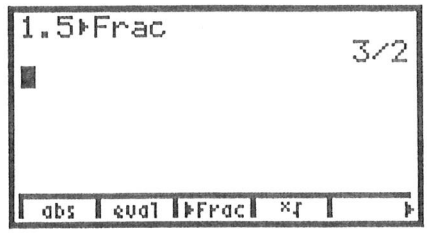
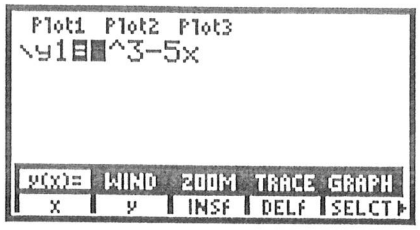


Table Values of an Equation

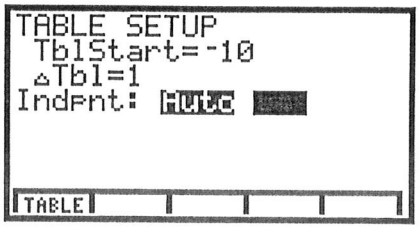
5. To begin creating a table requires that an equation is placed in the equation editor of the graphing section.
   a. Press the **GRAPH** button on the face of the calculator.
   b. Press the **y(x)=** menu item (F1).
   c. Type in the equation of interest. This example will use **x^3 –5x**.



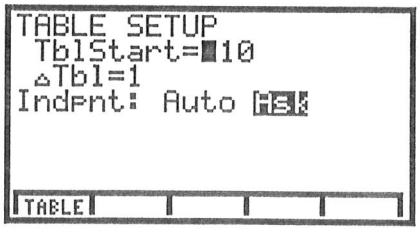
6. Press the **TABLE** button on the face of the calculator. Then press the **TBLST** menu item (F2).

7. The screen first asks for the TblStart, which is the first value that your table will start with. In this example, start with **-10**. Please note that the –10 is typed using the negative sign, not the subtraction sign. To move to the next input, press **ENTER** or the down gray arrow key.

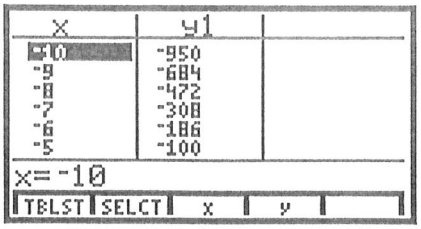
8. **Δ Tbl** is the size of the change (Greek letter "Delta") between x values in between each table entry. You may set this to 1 to get integer values (if your starting point is an integer). For this example, use 1.

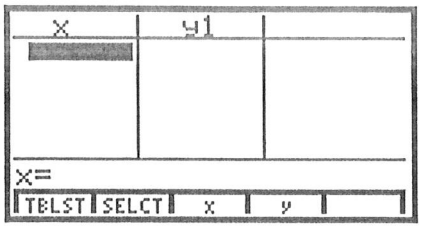


9. **Indpnt** normally should be set to **Auto.** In that case, the Table is created using the change in x that you inputted previously. **Ask**, on the other hand, allows you to create your own set of x values, independent of the fixed change in x previously entered. To change settings, press the left or right gray arrow key followed by the **ENTER** button.



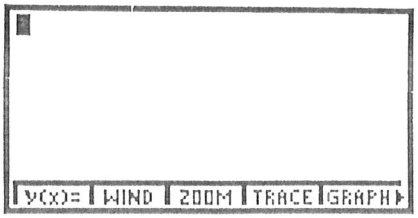
10. Press the **Table** menu item (F1).
    a. If you have set the calculator to create its own table values using delta x, then a table will appear: two columns, filled with the x and y values.
    b. If you set the calculator to ask you for the x values you want in the table, an empty table of two columns will appear, along with a space "x=" for you to type on the value of x that you want. Type the x value and press **ENTER**. Both the x value and the corresponding calculated y value will appear in the columns.
    c. Only the first six x and y values will appear on the screen. To see the rest scroll down using the gray down arrow.



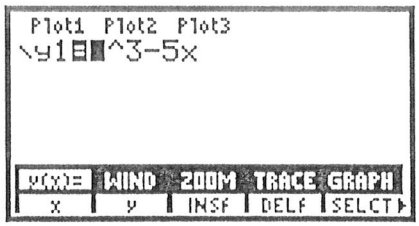


Graphing an Equation

1. Press the **GRAPH** button on the calculator face. There are five important menu items that appear.

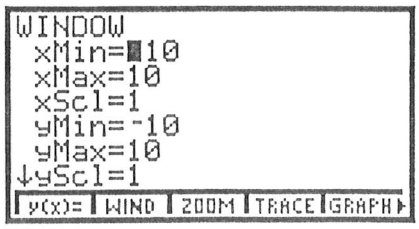


2. The first is the **y(x)=** menu. Press this menu item (F1). The cursor normally will appear next to the symbol "\y1=". This is where you will type in the equation that you wish to graph. For this example, use **x^3 - 5x**.

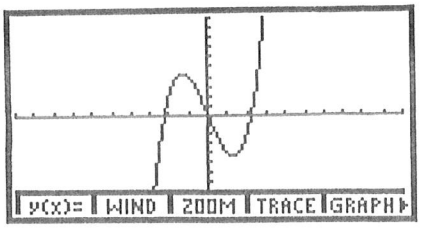


   a. If there are other equations already in the calculator, you will need to either remove them or turn them off. To remove an equation, place the cursor on the equation that you wish to change using the gray arrow keys, and press the **CLEAR** button on the face of the calculator. You may also completely erase the line containing the equation by pressing the **DELf** menu item (F4).
   b. To turn an equation off, place the cursor somewhere on the equation and press the **SELCT** menu item (F5). This will turn off the equation until you turn it back on again by pressing **SELCT** a second time. You can tell whether an equation is on or off by looking at the equals sign. One with the background on means the equations is selected on.

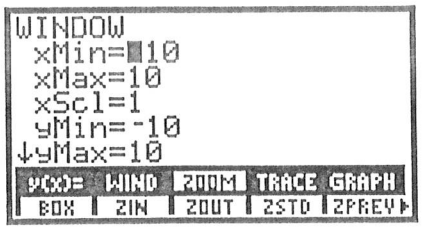
3. Next, set up the range of values for the x and y variables. Press the **WIND** menu item (F2 for the bottom menu, M2 for the top). The screen shows a series of inputs for the minimum and maximum x and y values. Note that "XScl=" describes the spacing between tick marks on the graph. XRes is the number of pixels skipped between points, and should normally be set to 1. When inputting a negative number, remember to use the gray negative sign at the bottom of the face of the calculator.



4. When you are ready to graph the equation, press the **GRAPH** menu item (F5). If **GRAPH** is in the higher row of items, make sure to press 2^{nd} prior to hitting **GRAPH**. To reduce the rows of items or stop graphing, press **EXIT** on the face of the calculator.



5. It is not necessary to always type in the values for the min and max of x and y. Press the **ZOOM** menu item (F3) to see the possibilities for adjusting the range of values for the window of the graph.



   a. The most often used menu item is **ZSTD** (F4) which stands for Zoom Standard. Pressing this sets the Window values back to the following::

      x and y min -10
      x and y max 10
      x and y scl 1

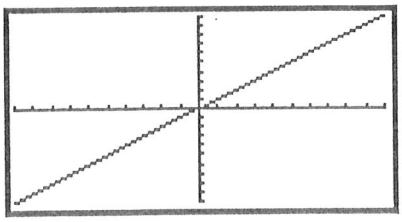
      This will automatically graph the equations that you have so far.

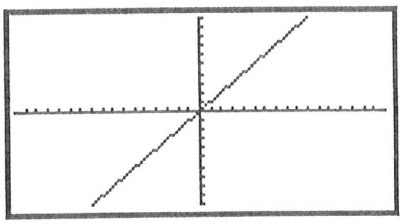
   b. **ZIN** (F2) shrinks the boundaries of the graphing window by a constant factor (default of 4). **ZOUT** does the opposite by expanding the screen. After pressing **ZIN** or **ZOUT**, use the gray arrow keys to select the center of the desired new screen, and then press **ENTER.**

   c. **BOX** (F1) allows you to draw a box around the perimeter of the region that you wish to view. Use the gray arrow keys and press **ENTER** to select the corners of the box. The inside of the box is then expanded to fill the entire screen.

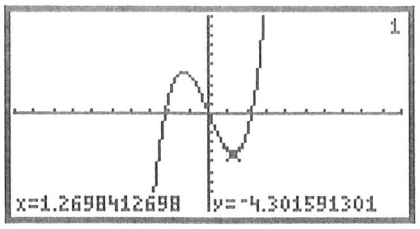
   d. **ZDECM** and **ZINT** force the cursor to move in increments of either .1 or 1, respectively. To find these menu items requires pressing the **MORE** button on the face of the calculator either once or twice, respectively.

   e. **ZSQR** sets equal size pixels in the x and y direction. For example, compare the image of the line y = x using **ZSTD** first, then **ZSQR.**





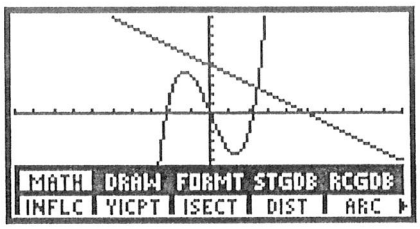
6. The calculator is capable of moving the cursor up, down, left and right, along with following a curve. In general, move the cursor anywhere using the gray directional arrows. The coordinates of the cursor are displayed at the bottom. Press the **TRACE** menu item (F4) and the cursor moves to the graph of the equation and flashes. Move the cursor along the curve with the left and right gray arrows. The up and down gray arrows in trace mode move the cursor from one equation to another (if there is more than one).



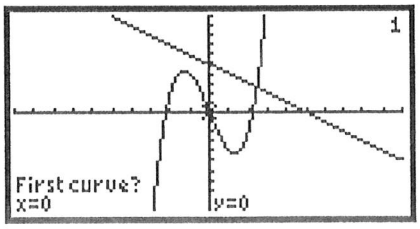
Finding Intersections and Intercepts

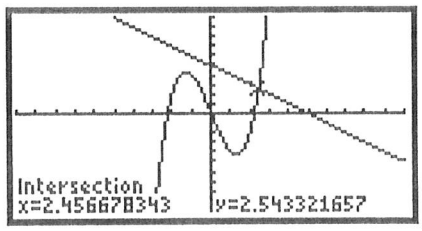
1. The x and y-intercept of a graph are related in the sense that they both occur when one of the variables is set equal to zero. However, the process used to find them is different. To begin with, let us use the process of finding an intersection of two curves to find an x-intercept. In preparation, place two equations in the equation editor. For this example, use y1(x)=x^3-5x and y2(x)=5-x.

2. Finding the coordinates of an intersection between two curves is done using the following sequence of menu items:
   a. **GRAPH** (face of calculator)
   b. **MORE** (face of calculator)
   c. **MATH** (F1)
   d. **MORE** (face of calculator)
   e. **ISECT** (F3)

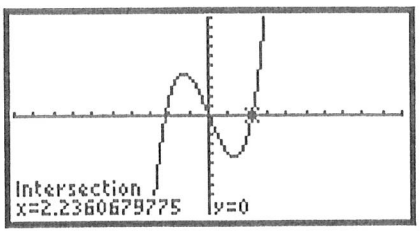


3. The **ISECT** menu item displays a question asking for the location of the first curve. This is not important if there are only two curves. Just press **ENTER**. Otherwise place the cursor on the first curve using the up and down gray arrows and press **ENTER**. Next press **ENTER** to show the calculator what the second curve would be. Finally the calculator asks for a guess as to the position of the intersection. This step is important, particularly if there is more than one intersection. Place the cursor near the intersection using the gray arrow keys. Press **ENTER** and the calculator states the coordinates of the intersection and places the cursor at the intersection.

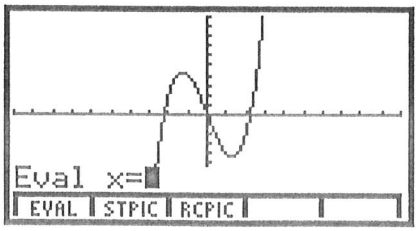


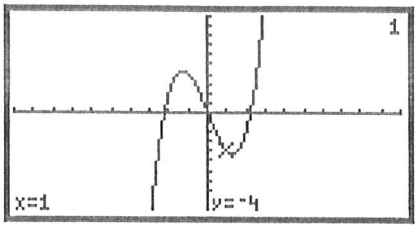


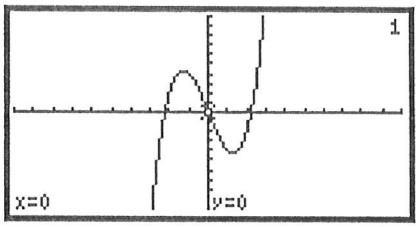
4. To find the x-intercept, make the second equation be y2(x)=**0**. Thus the intersection is where the first curve crosses the x-axis.



5. One of the ways of finding the y-intercept is by using the process of evaluation.
   a. Once you have placed an equation in the equation editor using the "y(x)=" menu item, press the **MORE** button on the face of the calculator twice.
   b. Press the **EVAL** menu item (F1). This will automatically draw the graph. It also displays "Eval x=" with the cursor flashing, waiting for you to type in an x-value.
   c. For this example, type in the number 1 for x and press **ENTER**. The menu will disappear and the x and y-value asked for will be displayed. The cursor on the graph moves to the corresponding position on the curve.
   d. To determine the y-intercept, just evaluate the equation with an x-value of x = 0.



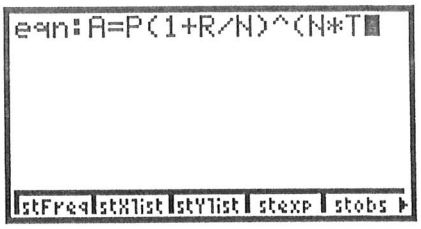




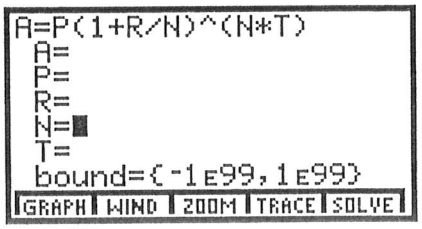
Solving an Equation for a Variable Value

5. The calculator is able to solve for the numeric value of any variable in an equation given the values of all the other variables. The calculator does not solve the equation symbolically. For this example, use the compound interest formula: $A = P(1 + \frac{R}{N})^{NT}$

6. Press 2nd **SOLVER** (see the **GRAPH** button) on the face of the calculator. The calculator asks for the equation. To input the equation from above, press **ALPHA A** (see the **LOG** button) to get the letter "A", followed by **ALPHA** = (see the **STO** button) to get the "=" sign. Continue in this manner, using parenthesis and the ^ button for the exponents. The calculator understands "NT" as a single variable "NT", not "N" times "T". You must type a multiplication sign between the letters.

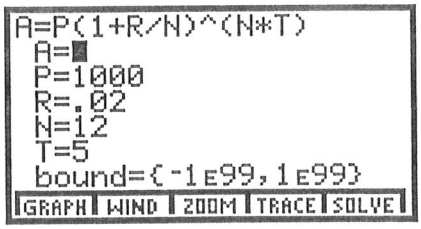


7. Press **ENTER**. A new screen will appear with the equation at the top. Check to make sure it is correct, and then type in the value for each variable, skipping over the unknown value.

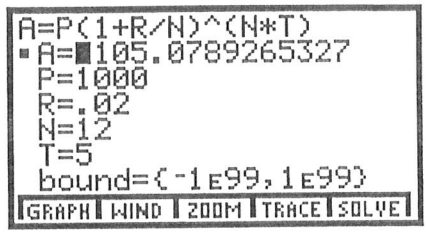


8. For this example, consider the following situation. What amount of money will you have at the end of 5 years if your bank account starts with $1000? Your account earns 2% and is compounded monthly. Place the cursor next to the appropriate variables (skipping A for now) and type in the following values:

   P=1000, R=.02, N=12, T=5.



9. Finally, place the cursor next to the letter A and press the **SOLVE** menu item (F5). The answer for A will appear after a while ($1105). You may use this process to solve for any one of the variables.

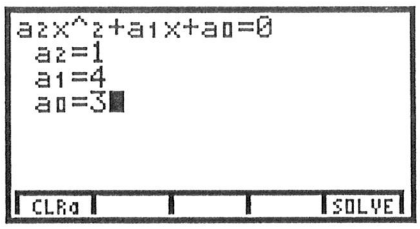


Solving Quadratic and other Polynomial Equations

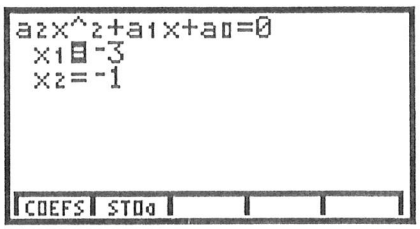
1. The calculator can solve quadratic equations and higher order polynomial equations. All that is needed is the coefficients of the polynomial. To begin, press **2nd POLY** (look above the **PRGM** button) on the face of the calculator.

2. Type the "order" of the polynomial equation. That is the value of the highest exponent. For this example of a quadratic equation, the order would be **2**.

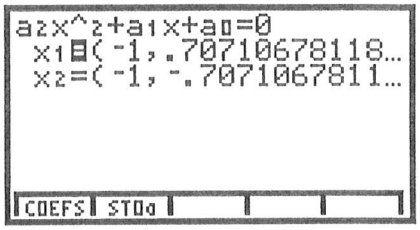
3. Type in the coefficients of the polynomial equation in descending order. In the case of the quadratic equation, the coefficients are more commonly represented by the letters "a", "b", and "c". On the calculator screen the coefficients are referred to as a_2, a_1, and a_0, where the subscript refers to the exponent of the particular term of the polynomial. For this example type **1, 4, and 3** respectively. You may move to the next coefficient by either pressing **ENTER** or using the down gray arrow key.



4. Press the **SOLVE** menu item (F5). The screen will show the solutions (two in this example) represented by x_1, x_2, etc.

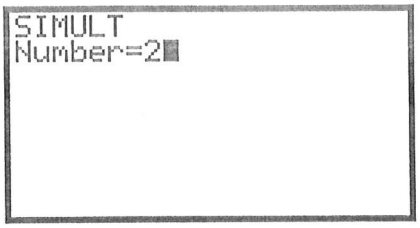


5. It is possible to have no real solutions to a quadratic or higher order polynomial equation. In this case these non-real solutions will be "complex" and be contained within parentheses. They will also seem to have two different solutions on the same line, separated by a comma. An example of polynomial coefficients with no real solutions would be 2, 4, and 3 respectively.



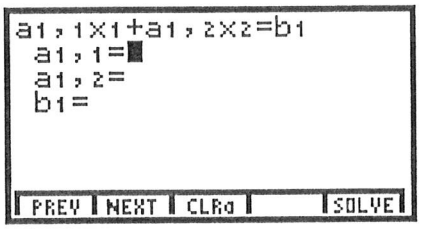
Solving Systems of Linear Equations

1. The calculator is able to simply solve most systems of linear equations when the number of equations and the number of variables are the same. To begin, press **2nd SIMULT** on the face of the calculator (look above the **TABLE** button).



2. The screen asks for the number of equations. For this example, type **2** for the number of equations and then press **ENTER**.

3. The screen now asks for the coefficients of the variables and the constant in the first equation. Although it is hard to read on the screen, the numbers next to the letters are actually subscripts. In normal print the screen would look like the equation below. The x's represent the variables in the equations. The a's represent the coefficients of those variables and the b's represent the constant at the end of the equation. Any system of linear equations must be in this format for it to be solved using **2nd SIMULT**.



$$a_{1,1}x_1 + a_{1,2}x_2 + \ldots = b_1$$

$$a_{1,1} =$$

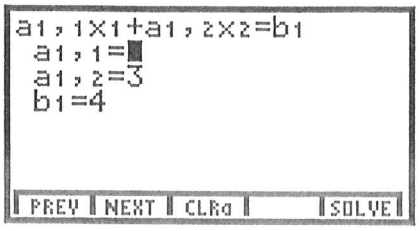
$$a_{1,2} =$$

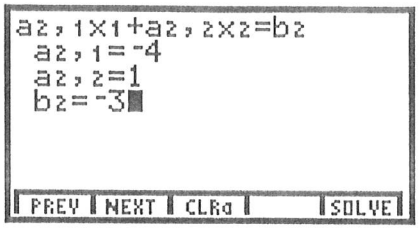
$$b_1 =$$

4. For this example, solve the following system of equations:

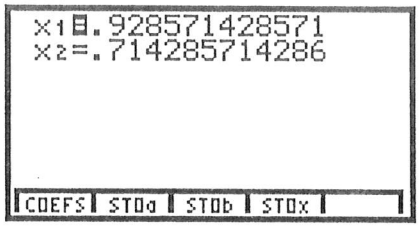
$$2x + 3y = 4$$
$$-4x + y = -3$$

Type in the first set of coefficients: **2, 3,** and **4**, using either the **ENTER** button or the down gray arrow. After entering the last number, the screen will move ahead to the next equation. In this case, type in **–4, 1** and **3**. Note that if there is no visible coefficient in front of a variable, then the coefficient is actually the number one. Also remember that the negative sign is in the gray button in the lower right hand corner.





5. Press the **SOLVE** menu item (F5). The solution to the system of equations is that x = .9286 and y = .7142.



6. There are some circumstances where either there are no solutions or an infinite number of solutions. For example, for the system

$$2x + 3y = 4$$
$$4x + 6y = 8$$

there are an infinite number of solutions, and the calculator will tell you there is a problem by stating that there is an error.