TI-84 Plus CE Tips & Tricks for Working with Expressions & Equations

30th Annual T^3 International Conference
San Antonio, Texas

Saturday, March 3, 2018
1:45 p.m. – 3:15 p.m.
Hyatt, Fourth Floor, Texas Ballroom D

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This handout can be downloaded at http://users.ipfw.edu/lamaster/technology

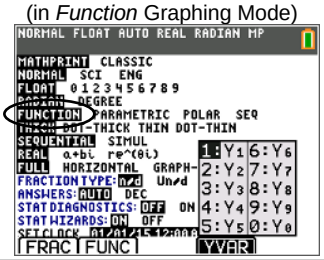
Tip: Use the shortcut menus to access MathPrint templates and Y-Vars.

Press [ALPHA] [F1]

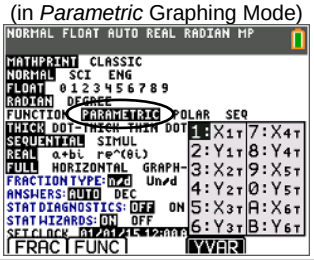
Press [ALPHA] [F2]

The items in the Y-Vars menu will depend on the *graphing mode*:

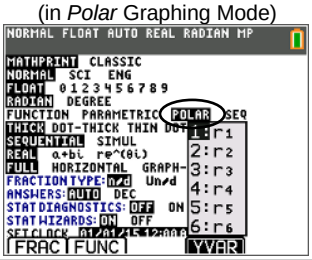
Press [alpha] [f4] (in *Function* Graphing Mode)



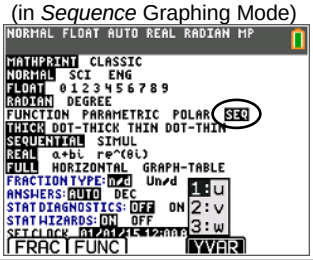
Press [alpha] [f4] (in *Parametric* Graphing Mode)



Press [alpha] [f4] (in *Polar* Graphing Mode)



Press [alpha] [f4] (in *Sequence* Graphing Mode)



Exploration: What's Next?

Use the TI-84 to find the following products. $1\frac{1}{3} * \left(1\frac{1}{4}\right) = ?$

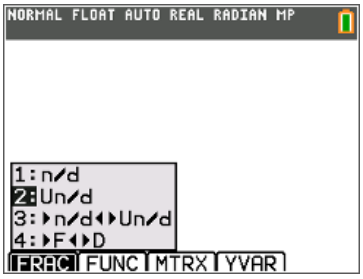
$1\frac{1}{5} * \left(1\frac{1}{6}\right) = ?$

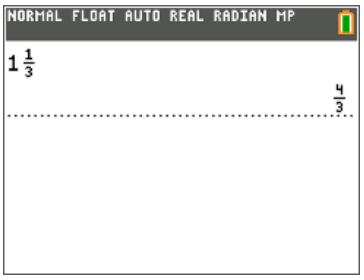
$1\frac{1}{7} * \left(1\frac{1}{8}\right) = ?$

What pattern do you see? Predict the next term.

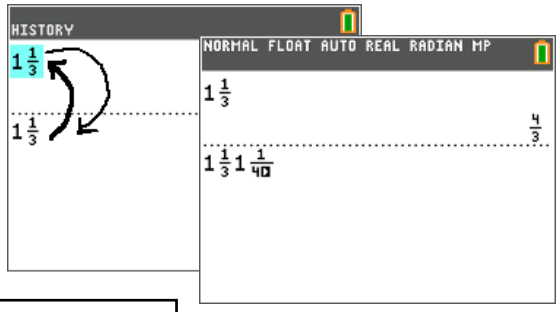
1. If needed, reset defaults (" [2nd] MEM 7 2 2").
2. From the home screen, press [alpha] [f1] and select the mixed fraction template **2: U n/d.** Type $1\frac{1}{3}$ and press [ENTER].

   Scroll the history stack to select previous expressions and edit them.





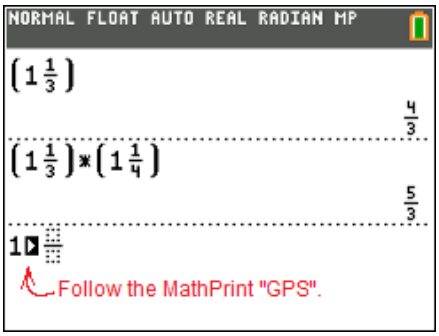
Tips: Press [ENTER] to replay the command.
Press ▲ to climb the history stack.
When up in the tree where the entries are, press [ENTER] to "pluck the fruit" off the tree.
Then edit the expression in in the entry line.
While up in the tree, you are not permitted to edit an expression.



Tips: While on the entry line and editing an expression….
Press [2nd] ◀ to move all the way to the ***front*** of the expression.
Press [2nd] ▶ to move all the way to the ***end*** of the expression.

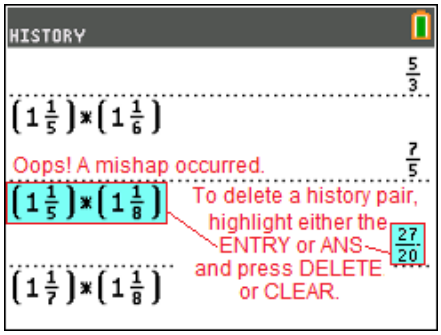
Tip: When using MathPrint templates, follow the guiding arrows.
Press ▶ to move up to the numerator (not ▲).

If you press ▲ you will move into the history.



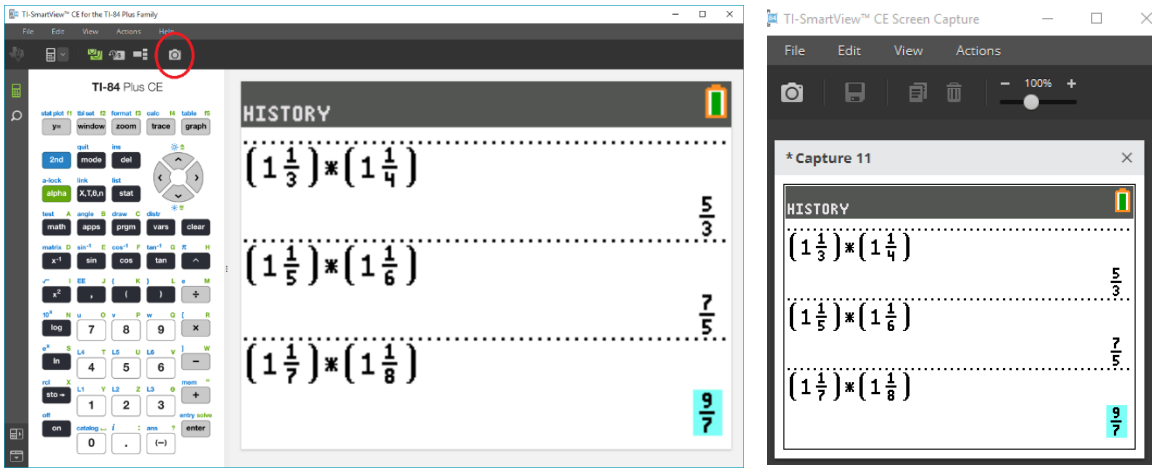
Tip: Suppose you make a mistake and press ENTER and your pattern in spoiled. No worries. You can delete or clear any history pair.

Press ▲ to highlight either the entry or the answer and press DEL or CLEAR. It is removed from the history stack as if you never had typed it.



3. Will your pattern work for $\left(1\frac{1}{99}\right)*\left(1\frac{1}{100}\right)$? Explain what is happening.

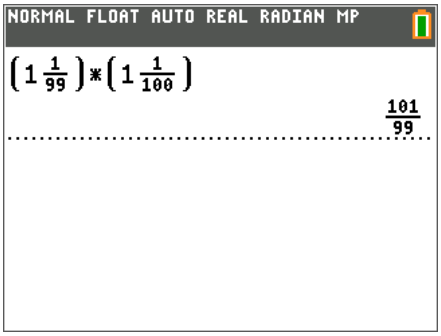
Tip: Need to see more on the screen? Click on the camera icon on TI SmartView to capture the screen.



Pair students together to foster a discussion on why the pattern works. Some may rewrite the product using improper fractions:

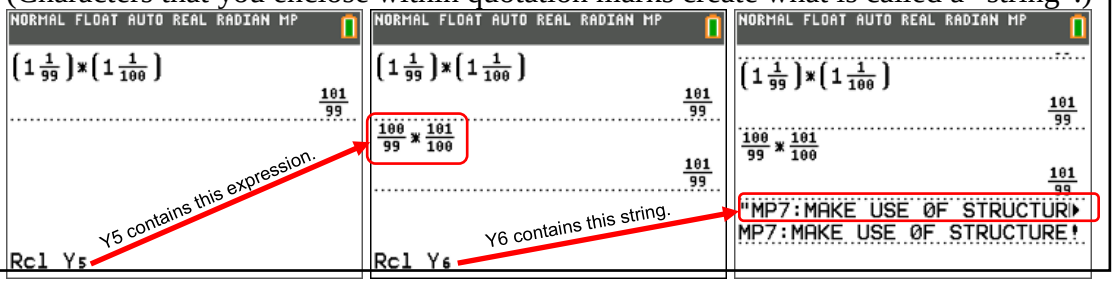
$$(1\tfrac{1}{99})(1\tfrac{1}{100}) = \frac{\cancel{100}}{99}\cdot\frac{101}{\cancel{100}} = \frac{101}{99}$$

To foster the discussion, it would be really cool if you could just quickly rewrite the expression $\left(1\frac{1}{99}\right)*\left(1\frac{1}{100}\right)$ using improper fractions right on the calculator on the next line by recalling it from a storage area.



Voila!

Tip: You can recall the contents of any variable.
Store what you want pasted in one of the registers in the Y= menu, say Y5.
Then use 2nd RCL alpha [F4] Y5. It can even be text (if in quotes).
(Characters that you enclose within quotation marks create what is called a "string".)



Tip: You can also recall the Last Entry from the home screen into the Y= Editor.
Make sure what you want to copy is the last entry.
Press 2nd ENTER to replay the command.
Press 2nd ENTER again to recall the previous entry in the history stack.
Repeat as desired.

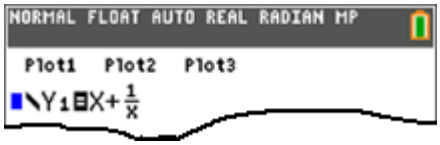
4. Will the pattern always work? Why or why not?
Based on the level of your students, algebra can be used to show the general pattern:

$$(1\tfrac{1}{n})(1\tfrac{1}{n+1}) = \frac{\cancel{n+1}}{n}\cdot\frac{n+2}{\cancel{n+1}} = \frac{n+2}{n}$$

In addition to the Common Core MP#7 *Look for and make use of structure*, this activity can help foster MP#8 *Look for and express regularity in repeated reasoning.*

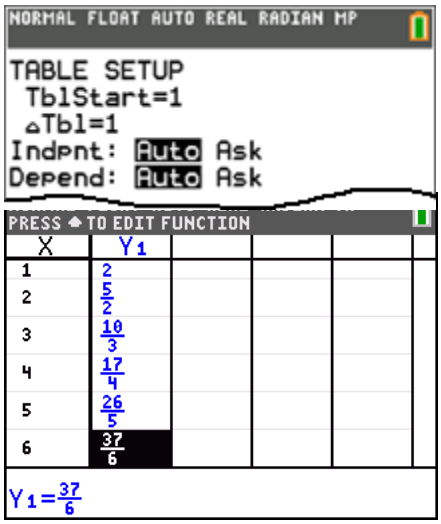
Exploration: Fun with Simplifying Rational Functions

1. Enter $x+\frac{1}{x}$ in Y1.



Press alpha [x,T,θ,n] for a shorter shortcut for n/d
This is a new feature in Operating System 5.3.
It is also still in the FRAC shortcut menu: alpha [F1].

2. Press 2nd [WINDOW]
Use the settings to the right to start at 1, climb in steps of 1, and automatically display the input and output.

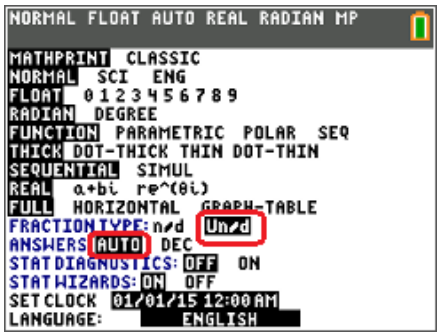


Using only the table of values, discuss the following

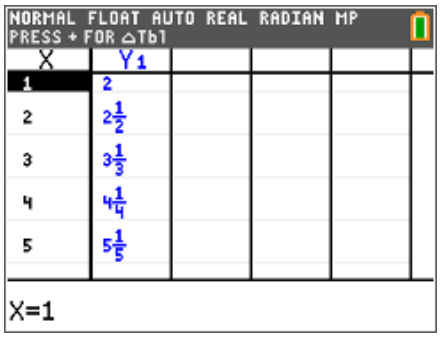
- What do you expect the next value to be?
- What pattern(s) do you see with the numerators? List as many patterns as you can find.
- Use the arrow key to continue the table to see if your prediction is correct.

3. Use algebra to simplify the expression in Y1. What information does this simplified expression provide to help confirm or extend your observations in the previous question?

4. With $x+\frac{1}{x}$ in Y1, press MODE.



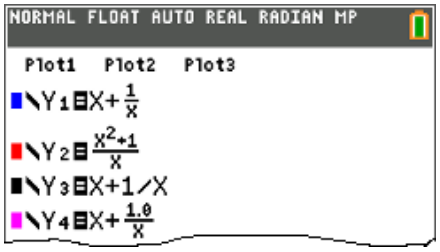
Change FRACTION TYPE to mixed **U n/d** .
AUTO should be highlighted for the ANSWER type.



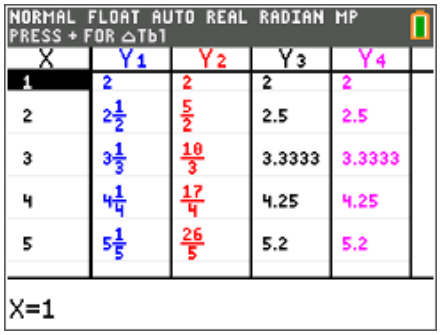
Explore the table.

5. In Y2, press alpha [F1] **1:n/d** to enter the expression as a stacked improper fraction.

Use the ÷ key to enter the expression shown in Y3.



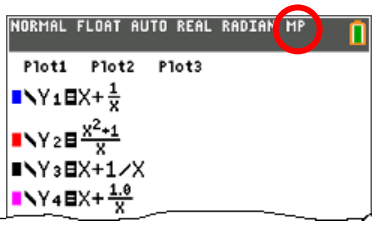
Explore the table.
What is happening?



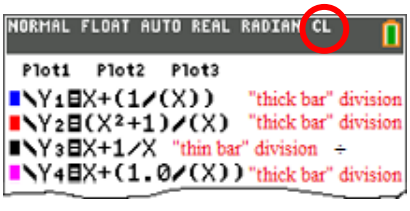
Tip: When the Mode setting for ANSWER type is AUTO, you can control the display.
Use ALPHA [F1] **1:n/d** (thick bar division) to get stacked fractions.
Use the ÷ key (thin bar division) to get decimal output.
Use **1:n/d** (thick bar division) and a decimal in the expression to force decimal output.

"Thick bar" and "thin bar" get their names from their appearance in CLASSIC Mode.

MATHPRINT Mode



CLASSIC Mode.



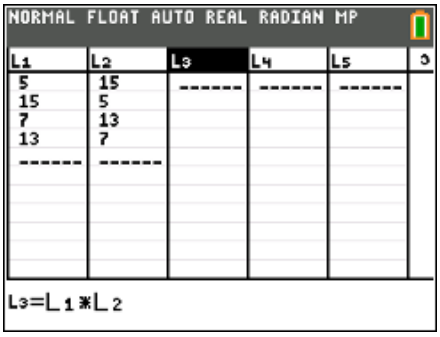
See the Website users.ipfw.edu/lamaster/technology/, click on the link to the handout and video for *2013 T³ International Conference: Bright Colors and More: See What the TI-84 Plus C Can Do*, and see **Investigation 1: Fun with Simplifying Rational Expressions** for more on this activity.

Exploration: Bringing Spreadsheet Power to the List Editor

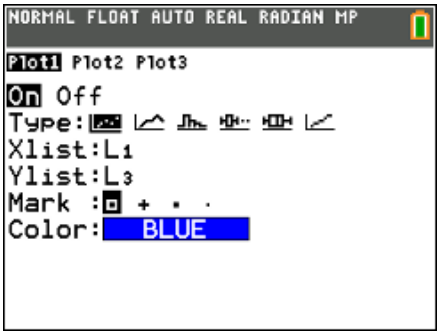
1. Ask students to write several pairs of numbers whose sum is 20.

   Press [STAT] [1:Edit] to enter the pairs in L1 and L2.
   Create the product L1*L2 in list L3.
   Sit your cursor on the top shelf on top of L3 and enter L1*L2.

   The columns L1 and L2 could represent dimensions of a rectangle and the column L3 could represent its area.



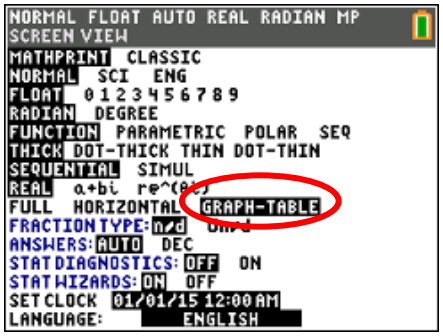
2. Press 2nd [STATPLOT]
   Set up the plot to show L3 vs. L1.

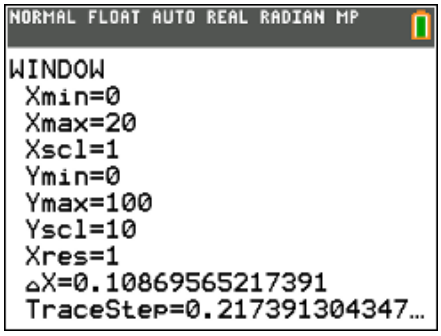


3. Press [MODE],
   highlight GRAPH-TABLE,
   and press ENTER.

   Press [WINDOW] and
   enter these settings.

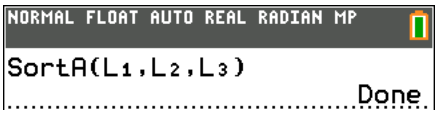
   Press [GRAPH].



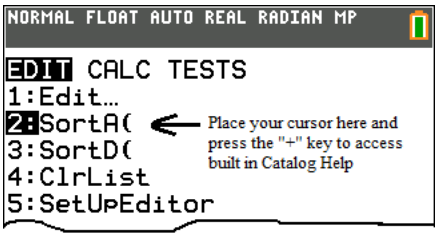


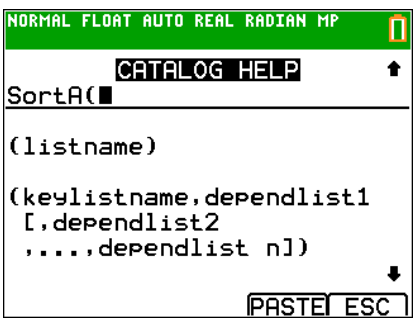
4. Press TRACE. Use the left and right arrow keys to hop from one point to the other in the order they were entered in the List Editor. Sorting is optional.

   To sort, first get to the home screen.
   One way we can sort the lists by column L1
   (and keep the values in each row of L2 and L3 together)
   is to enter SortA(L1, L2, L3). SortA(L1) would leave the lists L2 and L3 untouched.

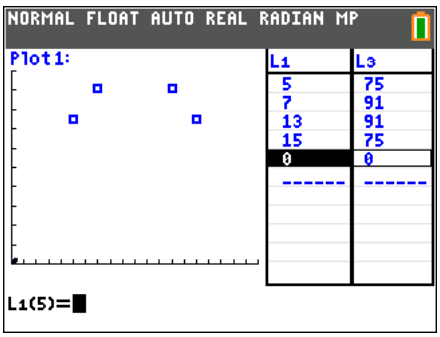


Tip: The TI-84C and the TI-84CE have built-in Catalog Help.



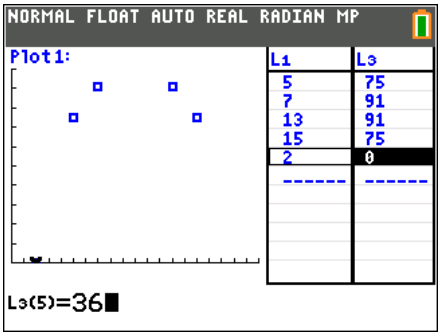


5. Press 2nd TABLE to access the right pane.
Press ▼ to reach the last empty row.
Press ENTER.
A new row is created with placeholder (0,0).

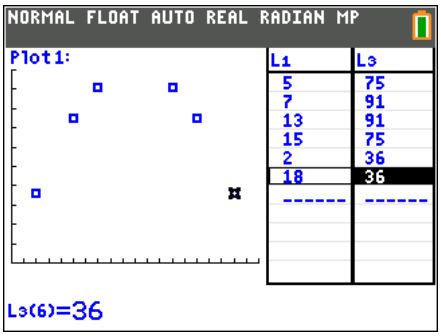


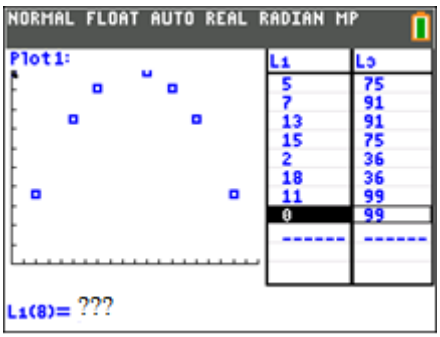
Type the width of a new rectangle and enter in L1.
Then compute its area and enter in L3.
For example, if the width is 2, its height is 18, and area is 36.

Warning: Plotting interactively works better if you have only **one plot active** or plots which have no dependencies. For example, if another stat plot was turned on that had L1 paired with a list other than L2, an error of Dimension Mismatch would occur when more elements to L1 are added or deleted.



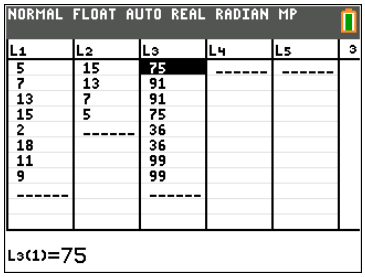
Include the width of a rectangle that has the same area as the one with width 2. Explore how this is related to the symmetry of the graph.



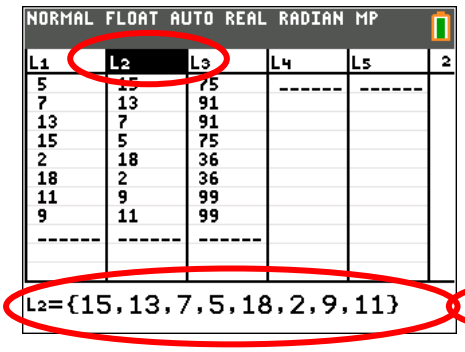


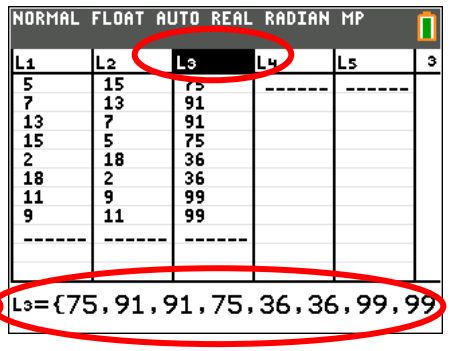
Tip: From the GRAPH-TABLE screen, if you highlight a row and press the DEL key, both pairs will be deleted so that no mismatch occurs. This kindness is not preserved if you highlight an element in the List editor.
In the List Editor, if you delete an element in L1, its match in L3 is not deleted.

6. Press STAT [1:Edit] .
Notice L2 did not dynamically change from the previous step.
However, we can "lock" the lists in the List Editor to link them together by preceding the formula with quotes.



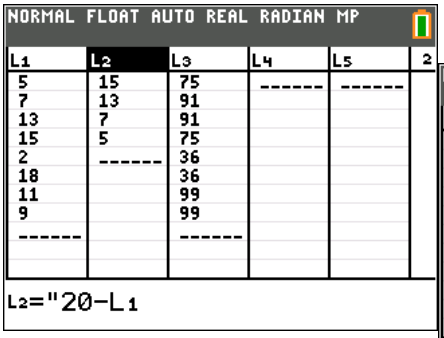
When lists are unlocked, notice when you sit your cursor on the list name on the top shelf, you see the contents of the list in curly braces.



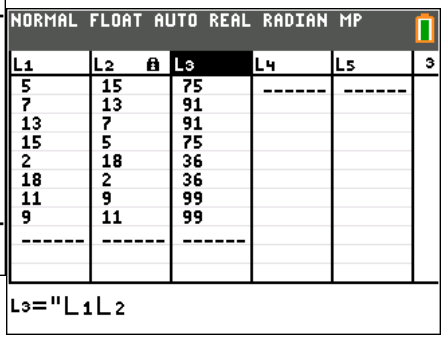


7. To lock the lists, use quotes.

Sit your cursor on the top shelf on top of L2 and enter
"20−L1
(The closing quote is optional.)



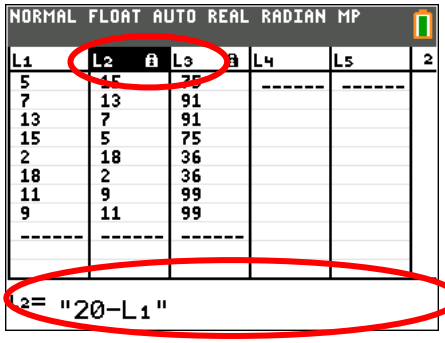
Sit your cursor on the top shelf on top of L3 and enter "L1L2

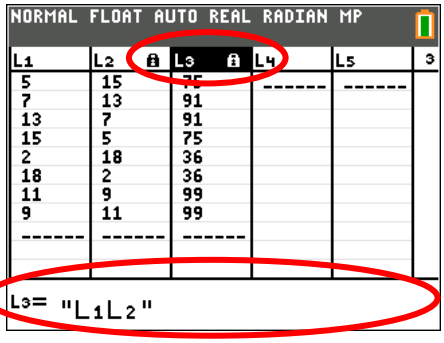


Notice the LOCK icon appears after the list name on the top of the column.

8. When you highlight the list name, you now can see the list formulas

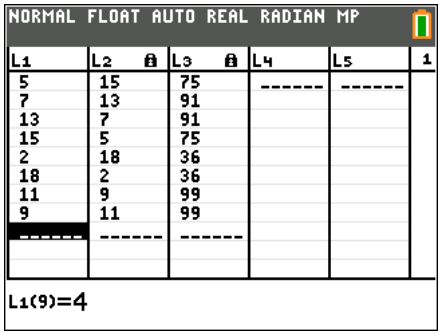
You **cannot** add any new elements to L2 and L3. (This demonstrates the concept of dependent variable.)

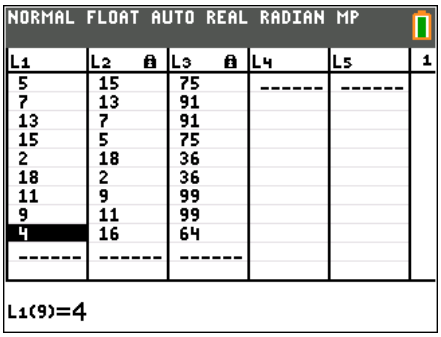




If you add/delete an element to L1, then L2 and L3 are updated automatically.

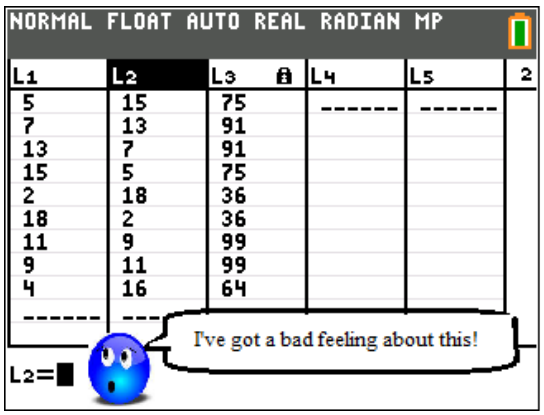
SortA(L1) will automatically carry along L2 and L3.





Important note: To unlock a list,
you highlight the name and press CLEAR
to remove the quotes.
The contents of the list remain.

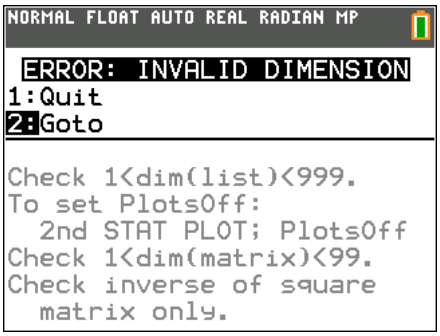
To clear the **contents** of the list, you would press clear once more. However, this could lead to trouble. If you clear the contents of L2 and the formula of L3 depends on L2, you will have a very unhappy calculator. Don't do this.



If you did choose to clear the contents you would get an Invalid Dimension error.

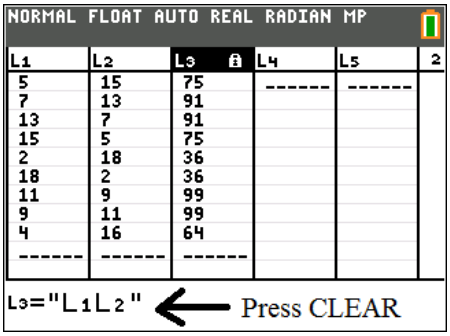
You can still recover but you must select **2: Goto**,

The calculator will then take you to the location that needs fixed.



Highlight the name of L3
(or whichever list has had the engine removed)
and press CLEAR to remove its quotes.

Once the dependency is removed,
the calculator's happiness will return.



Tip: Clear all quotes first before wiping out the contents of any list.

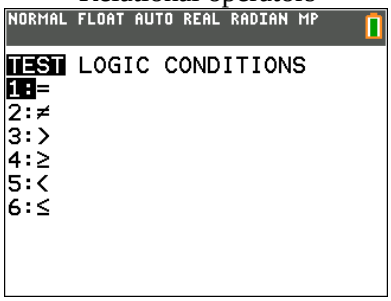
For a similar activities using the Graph-Table Mode with lists interactively, see the following:

- *Old MacDonald's Pigpen* at TI-84 Central.
- *Patterns with Rectangular Numbers from Multiple Perspectives* on John's Technology Page.

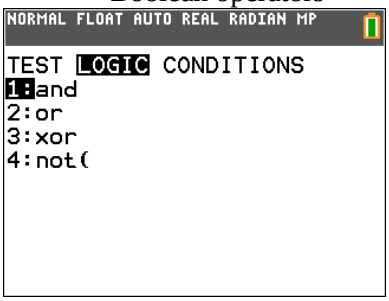
Exploration: The Piecewise Template and the Conditions Menu

In the TEST menu (2nd math) are relational operators, Boolean operators, and, new to the TI-84OS 5.3, the CONDITIONS Menu. All of these tokens can be pasted anywhere (Y=, programs, home screen, etc.) but the conditions were primarily created for faster entry of intervals in the new piecewise function template. To access the template in the Math menu, press math MATH **B:piecewise(**.

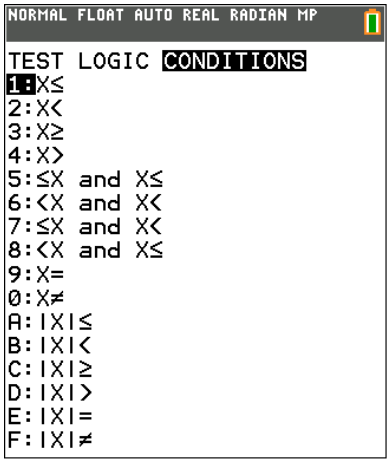
Relational operators



Boolean operators

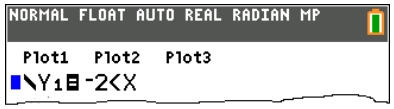


Conditions

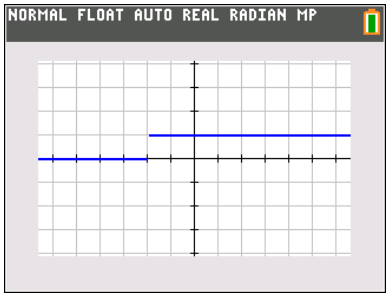


In the CONDITIONS Menu, selections 5 through 8 are ≤X and X≤, <X and X<, ≤X and X<, <X and X≤ and are **not** written as ≤X≤, <X<, ≤X<, <X≤ for a reason. Even though the shorthand notation `-2<X<1.5` that appears in textbooks is supported as a condition statement in a piecewise template, it has a different meaning if outside of the template. Let's explore what the calculator is doing.

1. The expression `-2<X` returns **1** for values of *x* which make `-2<X` true and returns **0** for values of *x* which make it false.

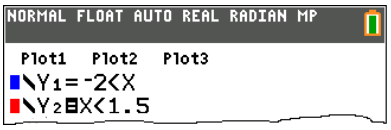


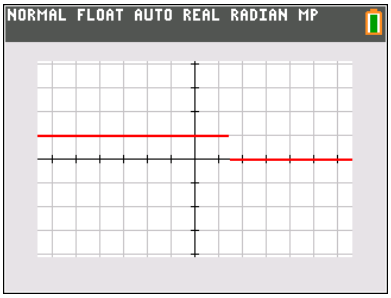
Press y= and enter `-2<X` in Y1.
Press zoom 4:ZDecimal.
Explore the table.



X	Y1
-3	0
-2.5	0
-2	0
-1.5	1
-1	1
-0.5	1
0	1
0.5	1
1	1
1.5	1
2	1

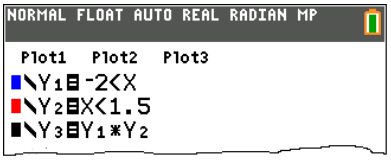
Press y= and enter `X<1.5` in Y2.
Press graph.

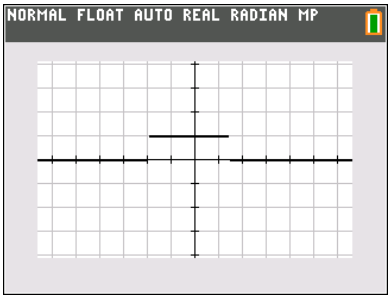


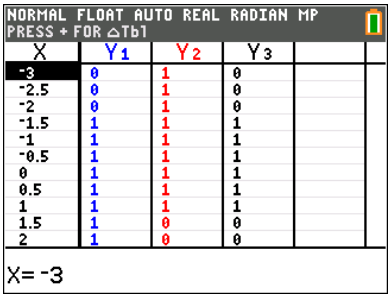


X	Y2
-3	1
-2.5	1
-2	1
-1.5	1
-1	1
-0.5	1
0	1
0.5	1
1	1
1.5	0
2	0

2. In Y3 enter Y3=Y1*Y2.
Use alpha [f4] (above the trace key) for the y-vars.

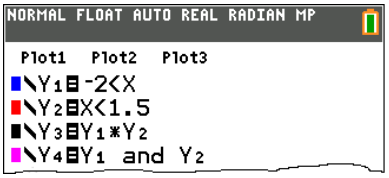


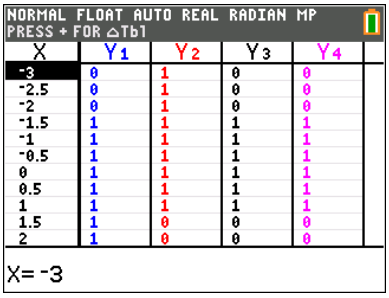




Compare with using the Boolean operator:
Y4=Y1 and Y2

Y3 and Y4 are equivalent.



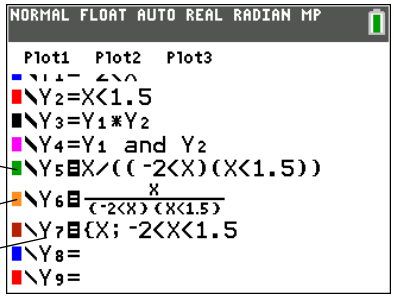


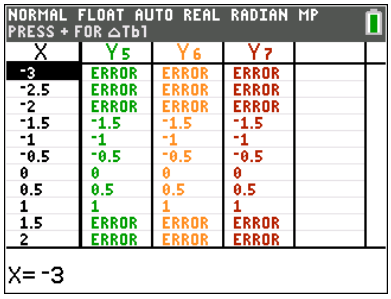
3. Based on the above, we can graph $y = x$, $-2 \le x \le 1.5$ several ways.

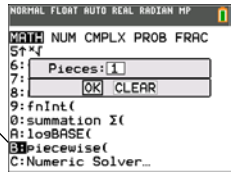
In Y5 we must watch parentheses.

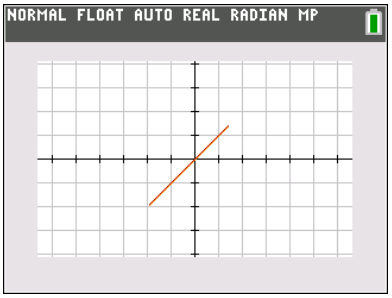
For Y6, press alpha [X,T,θ,n] for quicker access to the n/d template.

In Y7, press math MATH **B:piecewise(**, select number of pieces and enter the expression. We can use -2<X<1.5 in this template.





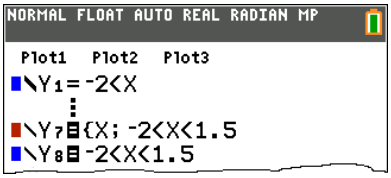


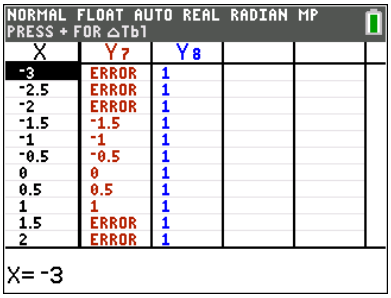


Y5, Y6, and Y7 are equivalent.

Note: We could also use the Boolean -2<X and X<1.5 in place of the product.

4. However Y8=-2<X<1.5 returns all 1's. Why?

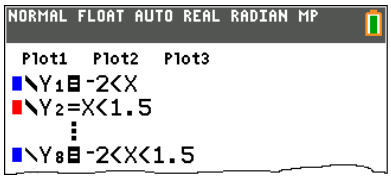


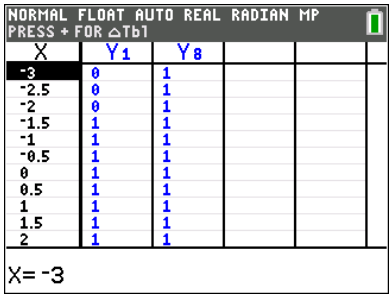


To answer this, let's examine Y1 and Y8.

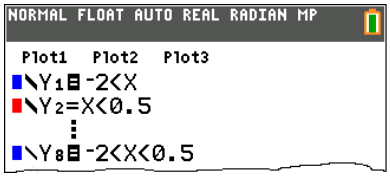
The expression $-2<X$ is always one of two numbers: 0 or 1.

Both 0 and 1 are less than 1.5, so $Y_8 = -2<X<1.5$ returns all 1's.





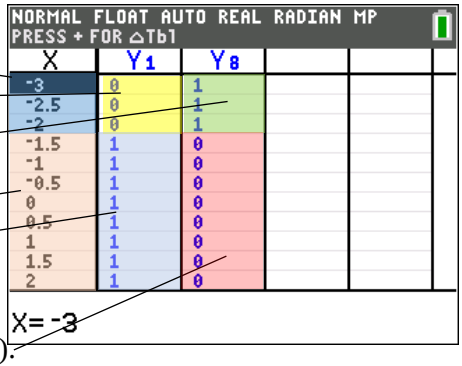
5. This may be more interesting if we change Y8 so that the endpoint is any value smaller than 1, say 0.5.



6. There are two possibilities:

- for values of x which are less than or equal to -2, $-2 < x$ is false (or **0**).
  Thus, $(-2 < x)$ in Y2 returns **0**.
  Consequently, $-2 < x < 0.5 \Leftrightarrow (-2 < x) < 0.5 \Leftrightarrow 0 < 0.5$ which is true (so Y8 = **1**).

- for values of x which are greater than -2, $-2 < x$ is true (or **1**).
  Thus, $(-2 < x)$ in Y2 returns **1**,
  so $-2 < x < 0.5 \Leftrightarrow (-2 < x) < 0.5 \Leftrightarrow 1 < 0.5$ which is false (so Y8 = **0**).

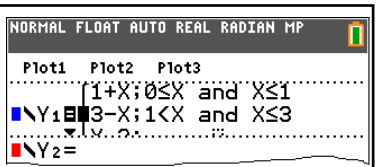


Because of the Boolean use of 0 and 1, more interesting things occur outside of the piecewise template for an interval $a < x < b$ when $b \le 1$, and more interesting things occur for $a < x \le b$ when $b < 1$.
The machine is really doing what it is supposed to, but it is unexpected.

Tip: Use the Boolean operator **and** when you are outside the piecewise template ≤X and X≤ / <X and X< / ≤X and X< / <X and X≤ ;
if you use the textbook interval notation ≤X≤ / <X< / ≤X< / <X≤, only use it inside the piecewise template.

Other piecewise template tips:

Tip: Entering a piecewise directly in Y= can be challenging since the screen real estate is very small. However, you can type it on the home screen and store it in Y=. It must be surrounded with quotes.



Tip: The Boolean value 1 (true) and 0 (false) can be used as conditions. If you change your mind and want 2 pieces instead of 3, enter 0 in the condition to have any piece ignored.