Teachers Teaching with Technology™
Professional Development from Texas Instruments

# Exploring Common Core Topics in High School Mathematics with the TI-84 Plus Family


Materials for Workshop Participant*

# $T^3$ Professional Development Categories and Learning Objectives

There are three categories of $T^3$ Professional Development, each with a unique set of learning objectives. This workshop is focused on content knowledge, and its objectives are as follows:

### Content Knowledge

- Emphasis on content with technology as support
- Addresses critical, tough-to-teach topics and new content standards for CCSS or TEKS
  - I have a deeper understanding of the mathematics and science in my content area, and I am aware of the shifts in content that affect what I teach.
  - I can design opportunities for students to use technology as a tool to deepen their understanding of mathematics and science.
  - I can locate and download TI activities that align to my standards.
  - I can describe the role technology should play in the successful implementation of my standards, and I can implement a vision of a classroom where students routinely use technology to engage in the practice and content standards.

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Workshops focused on instructional practices and technology integration have the following objectives:

### Instructional Practices

- Emphasis on classroom practices with technology as a tool to enhance student learning
- Models CCSS, TEKS, and NGSS tasks using in-depth discussions, reflective practices, and essential technology skills
  - I can demonstrate the importance of teacher actions for students' engagement in the Practices, and I can take actions that will enable students to become mathematical and scientific practitioners.
  - I can describe the role that technology should play in the successful implementation of my standards, and I can implement a vision of a classroom where students routinely use technology to engage in practice and content standards.
  - I can design tasks for students to employ the Practices, using technology as a tool to deepen their understanding of mathematics and science.
  - I can ask questions designed to make student thinking visible – to push them to think about connections, make comparisons, or probe their understanding.

### Technology Integration

- Emphasis on learning to use TI technology, with broad "how-to" coverage highlighting a wide range of features
- Subject/content-focused training on appropriate usage of TI technology in the classroom
  - I am comfortable with essential technology skills for exploring math and science content.
  - I can design opportunities for students to use technology as a tool to deepen their understanding of mathematics and science.
  - I can locate and download TI activities that align to my standards.
  - I can describe the role technology should play in the successful implementation of my standards, and I can implement a vision of a classroom where students routinely use technology to engage in the practice and content standards.

# Exploring Common Core Topics in High School Mathematics with the TI-84 Plus Family

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# Introduction to the TI-84 Plus CE Graphing Calculator

**TI PROFESSIONAL DEVELOPMENT**

## Activity Overview

*This activity introduces basic features of the TI-84 Plus CE graphing calculator.*

### Concepts

- Order of operations
- Scrolling history
- Patterns
- Home screen
- Shortcut keys

### Compatible TI Technology

- TI-84 Plus CE
- TI-84 Plus C Silver Edition
- TI-84 Plus Silver Edition
- TI-84 Plus

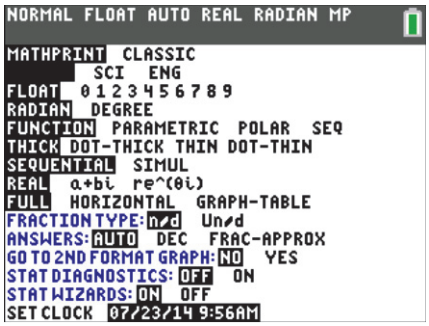
### Introduction to the Keys

1. This activity begins with an introduction to some basic keys on the TI-84 Plus CE. Simply look at the face of the calculator and locate:
   [ON] [ENTER] [MODE] [2nd] [CLEAR] [(-)] [+] [−] [×] [÷] [^] [$x^2$] [X,T,Θ,n] [APPS]

2. Press [MODE]. Make sure all items on the left are highlighted.

   - The default settings are shown.
   - To restore the calculator to the default settings it has when it comes out of the box, you can also press

     [2nd] [MEM] 7:Reset.. 2:Defaults…2:Reset…




### MathPrint™ and Classic Modes.


3. Both MathPrint™ and Classic modes contain the same new functions.

**MathPrint** mode provides additional matrix shortcuts from the F3 soft key and displays on the home screen and Y= editor most inputs and outputs the way they are shown in textbooks, such as $\frac{1}{2}+\frac{3}{4}$ and $\sum_{k=1}^{100} kx^2$.

**Classic** mode displays expressions and answers as if written on one line, such as `1/2+3/4` or `Σ(KX^2,K,1,100)`.

**Note**: If you switch between these modes, most entries typed on the home screen will be preserved; however matrix calculations will not be preserved unless you store them. Think of them as images drawn on the screen.

**n/d U n/d** - selection of fraction output as improper or mixed numbers.

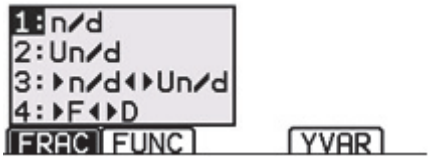
**Answers**

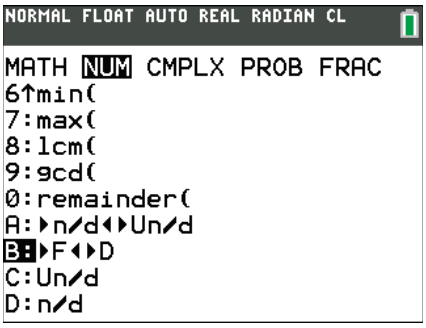
- **Auto** displays answers in a similar format as the input. For example, if a fraction is entered in an expression, the answer will be in fraction form, if possible.
- **Dec** displays answers as integers or decimal numbers.
- **Frac** displays answers as their fractional approximation, if possible.

The **ANSWERS** mode setting also affects how values in sequences, lists, and tables are displayed.

If any decimal point appears in the expression, then the output is a decimal. This is a quick way to force decimal output in **AUTO** mode.

You can also convert values from decimal to fraction or fraction to decimal using the **FRAC** shortcut menu or the MATH NUM menu.




**GOTO FORMAT GRAPH:** Selecting YES jumps from the MODE screen to the FORMAT screen. This shortcut puts the FORMAT screen on the user's radar as a place to check to avoid calculator glitches as well as helping to support teachers who begin an activity making sure all is highlighted on the left on both screens. Pressing MODE will return to MODE from the FORMAT screen.

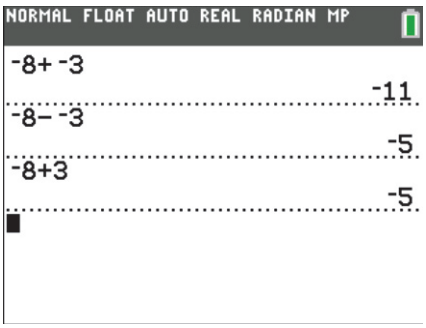
**STAT DIAGNOSTIC ON OFF -** Quickly select the existing option of displaying $r$ and $r^2$ when calculating statistical regressions. This is a shortcut to an existing feature (only found in the catalog under `DiagnosticOn` or `DiagnosticOff`) which is placed here for ease of use.

**STAT WIZARDS ON OFF** – ON walks you through setting up regression equations.

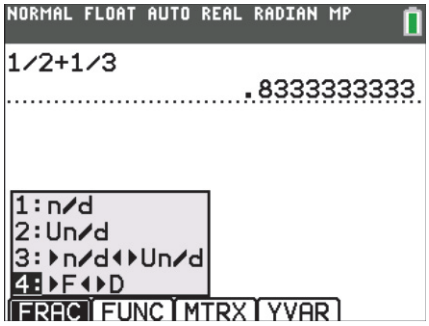
**SET CLOCK** allows you to set the internal clock.

4. Press [2nd] [QUIT] to return to the Home Screen ("Quit and Go Home") and try the following. Press [ENTER] after each command. Note the difference in appearance on the screen between [(-)] for negation and [−] for subtraction.

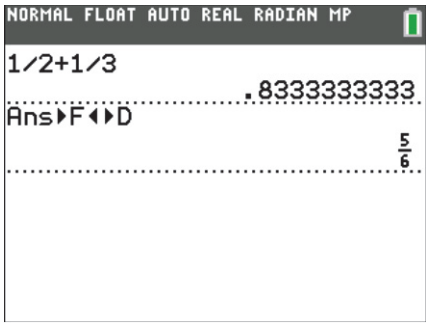
   −8 + −3  −8 − −3  −8 + 3



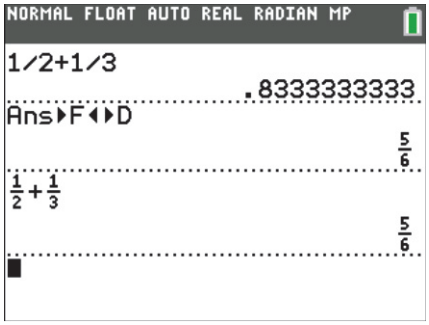
5. Press [CLEAR]. Enter the sum $\frac{1}{2}+\frac{1}{3}$ using the [÷] key.



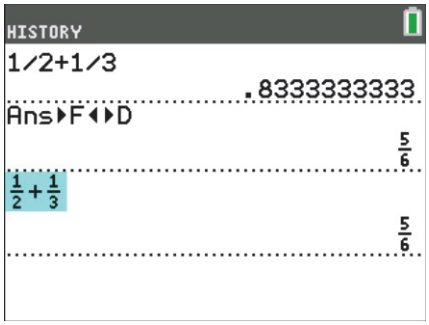

- Press [ALPHA] [F1] to reach the Fraction short cut menu. Select ▸F◂▸D to convert a decimal to a fraction or vice versa.
- You can also press [MATH] [1] ▸Frac to "frac" a decimal expression.
- Once you have selected a shortcut menu, you can use the [◂] and [▸] to move from one shortcut menu to another.




- Press [ALPHA] [F1] to use n/d to enter $\frac{1}{2}+\frac{1}{3}$ as stacked fractions. Press [ENTER].

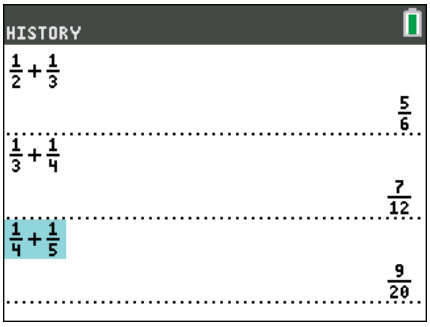



- Press [▲] to climb the history stack to highlight the entry $\frac{1}{2}+\frac{1}{3}$. Press [ENTER] to bring this down to the entry line.
- You can use the arrow keys to edit it the expression. Type $\frac{1}{3}+\frac{1}{4}$.




**Tip:** Press [2nd] [◂] to move to the beginning of the entry line and [2nd] [▸] to move to the end.

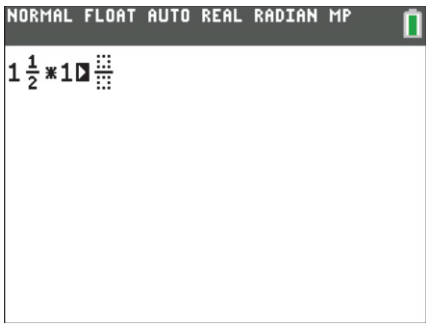
- Press [ENTER]. Continue the pattern. Predict the next value. Will it work for $\frac{1}{20}+\frac{1}{21}$?




Discuss:

- What patterns do you notice?
- Will it always work? Justify with algebraic reasoning.

6. Press [ALPHA] [F1] and use Und and scrolling history to create these expressions on your home screen.




$1\frac{1}{2}\cdot 1\frac{1}{3}$

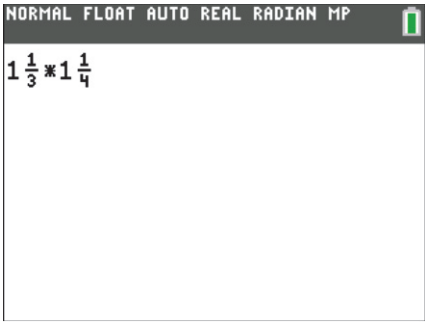
$1\frac{1}{2}\cdot 1\frac{1}{3}\cdot 1\frac{1}{4}\cdot 1\frac{1}{5}$

$1\frac{1}{2}\cdot 1\frac{1}{3}\cdot 1\frac{1}{4}\cdot 1\frac{1}{5}\cdot 1\frac{1}{6}\cdot 1\frac{1}{7}$

**Tip:** Follow the guiding arrows in the math template. For example, you press the right arrow key to reach the numerator, not the up arrow key.

Predict the next term. Explain what is happening.

7. Create these expressions on your home screen. Use Und.




$1\frac{1}{3}\cdot 1\frac{1}{4}$

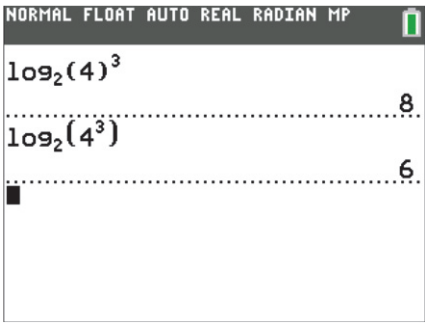
$1\frac{1}{5}\cdot 1\frac{1}{6}$

$1\frac{1}{7}\cdot 1\frac{1}{8}$

Predict the next term.

Will it work for $1\frac{1}{99}\cdot 1\frac{1}{100}$? Explain what is happening.

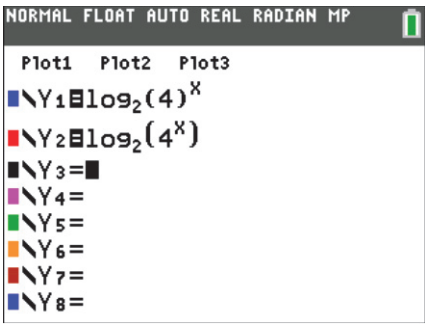
8. Create these expressions on your home screen using the [ALPHA] [F2] shortcut.




Use properties of logarithms to explain what is happening.

Note: logbase( can also be accessed from the [MATH] MATH menu.

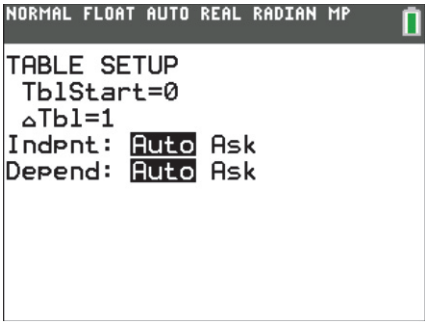
- Press [Y=] and enter these expressions in the Y= Editor.

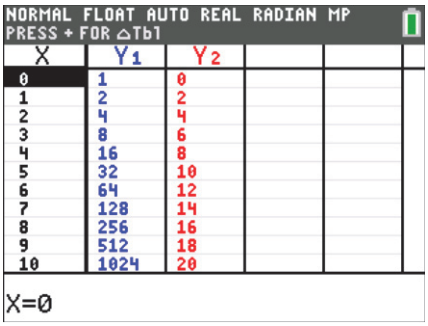


- Press [2nd] [TBLSET] to start your table at 0 and increase in steps of 1. Press [2nd] [TABLE] to observe the table.

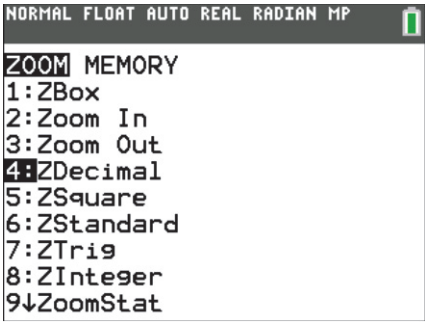
  For what value(s) of *x* are these expressions equal?

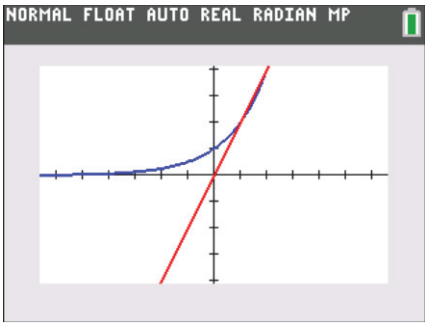
  What is simplified form of each?




- Press [ZOOM] and select 4:ZDecimal. Press [GRAPH].



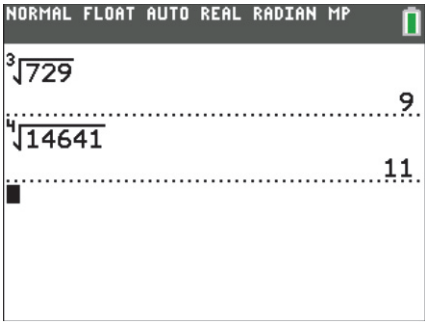




9. Find the following roots.

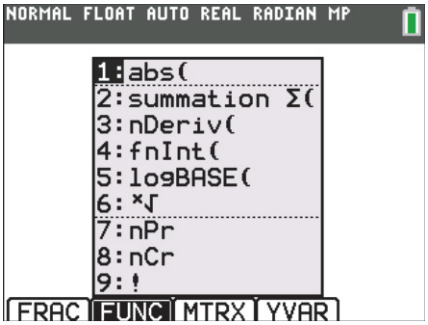
   $\sqrt[3]{729}$ Press [MATH] 4:$\sqrt[3]{}$( [7] [2] [9] [ENTER]

   $\sqrt[4]{14641}$ Press [4] [MATH] 5:$\sqrt[x]{}$ [1] [4] [6] [4] [1] [ENTER]

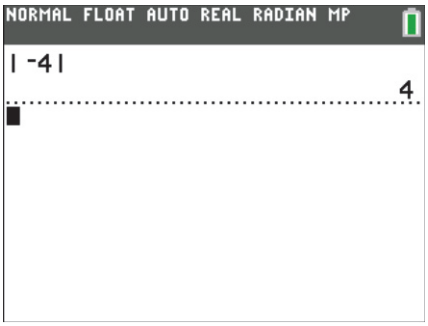
   **Note:** You can also use [ALPHA] [F2] to access $\sqrt[x]{}$.



10. Various other functions follow:



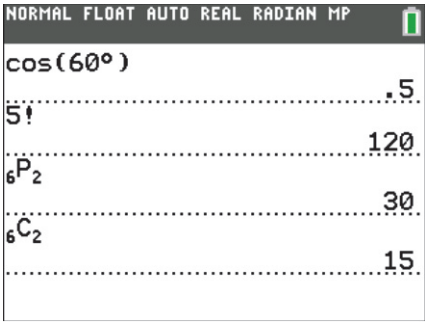

$|-4|$ Use shortcut menu [ALPHA] [F2] or press [MATH] ▸ Num 1:abs(.




$\cos(60^\circ)$ Press [COS] [6] [0] [2nd] [ANGLE] 1:° [)]

It makes no difference if in the TI-84 Plus CE is in degree or radian mode.

5! Use shortcut menu [ALPHA] [F2] or press [5] [MATH] ▸ ▸ ▸ Prob 4:!
This computes $5! = 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1 = 120$.




${}_6P_2$ Use shortcut menu [ALPHA] [F2] or press [6] [MATH] ▸ ▸ ▸ Prob 2:nPr [2].

This is a permutation. For example, how many possible ways can there be a President and Vice President elected out of a club of six members?

If the six members are A, B, C, D, E, and F, then AB is a different outcome than BA. All outcomes are:

AB, AC, AD, AE, AF, BA, BC, DD, BE, BF,
CA, CB, CD, CE, CF, DA, DB, DC, DE, DF,
EA, EB, EC, ED, EF, FA, FB, FC, FD, DE

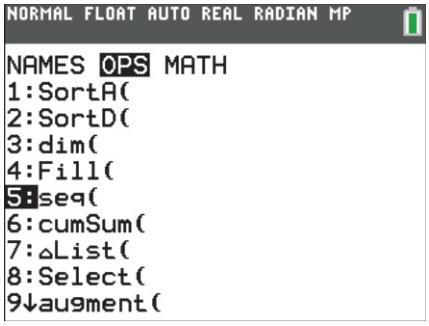
${}_6C_2$ Use shortcut menu [ALPHA] [F2] or press [6] [MATH] ▸ ▸ ▸ Prob 3:nCr [2].

This is a combination. For example, how many possible ways can there be a two member subcommittee chosen from the above club of six members?

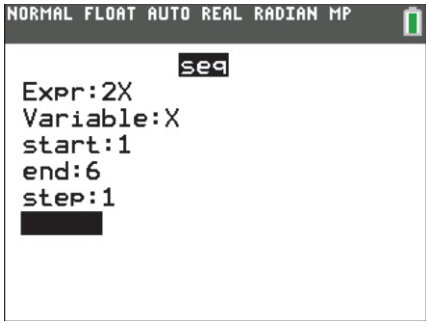
Then AB is no different than BA, since that represents the same subcommittee. So there would be fewer outcomes than for ${}_6P_2$ – in fact, in this case, half as many.

11. Create the sequence {2, 4, 6, 8, 10, 12}.

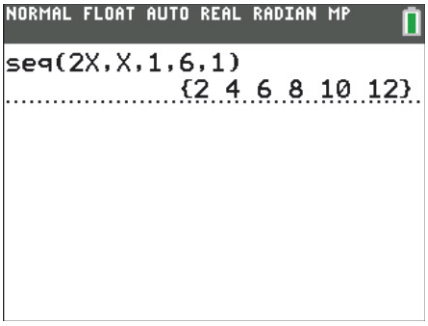
- Press [2nd] [LIST] > **OPS** 5: seq(.




- Fill in the values, highlight Paste, and press [ENTER] to paste the command to the home screen.




- Once the command is on the home screen, press [ENTER].



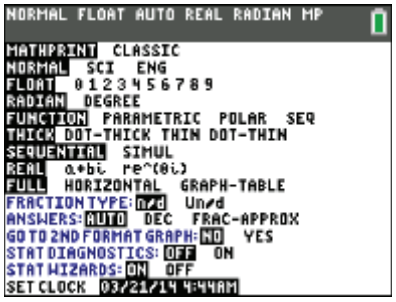

12. With the TI-84 Plus CE in Normal mode, enter the following:

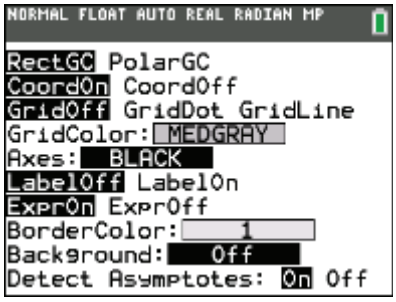
$2 \times 10^{4}$
$2.5 \times 10^{4}$
$2 \times 10^{-4}$
$2.5 \times 10^{-4}$

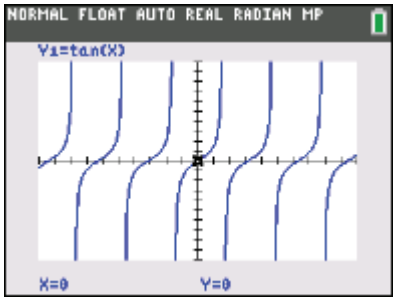
13. With the TI-84 Plus CE in Scientific mode, enter the following:

275000000
0.0000025
$200 \times 10^{6}$

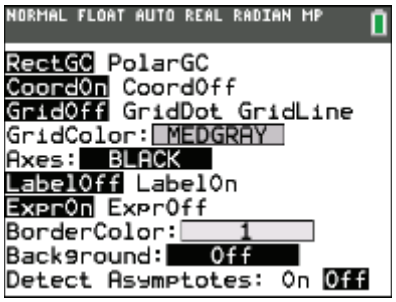
14. The Graph Format screen ([2nd][FORMAT]) on the TI-84 Plus CE enables you to choose whether or not to Detect Asymptotes when graphing. When set to On (the default), the calculator checks each pixel as the graph is displayed to see whether or not there is a singularity (undefined value). For example, if you graph $y = \tan x$ in radian mode with linestyle Thick or Thin in a standard window, you will see the following.

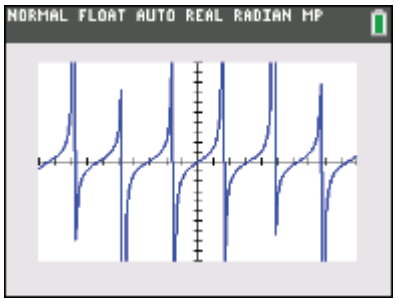


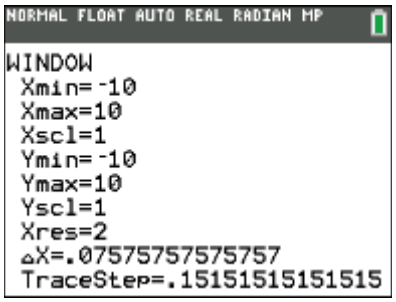

However, if Detect Asymptotes is set to Off, the graphing speed is faster but it will connect the points on each side of an undefined value.




Some students call these “false asymptotes,” but they really are just connections over vertical asymptotes for which $y \to \infty$ on one side and $y \to -\infty$ on the other. If a graph does not exhibit these kinds of asympotes, change Detect Asymptotes to Off to increase graphing speed.

On the TI-84 Plus CE, you can also change the graphing speed from the WINDOW screen. Set Xres to 1, 2, 3, …, 8 to graph every pixel, every 2 pixels, every 3 pixels, …, every 8 pixels, respectively. The asymptote detection feature only occurs when Xres=1.




What other features do you notice on the Graph Format screen?

## Activity Overview

*In these investigations, you will look at how the TI-84 Plus CE can be used to implement the Common Core Mathematical Practices. In the process, we will learn about various TI-84 Plus CE features.*

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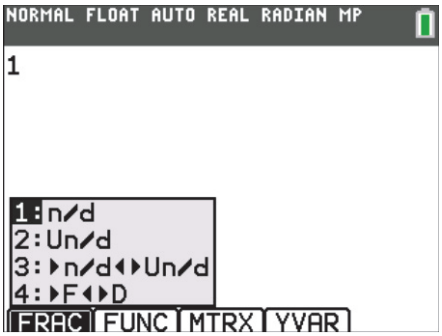
The Common Core State Standards for Mathematical Practice describe varieties of expertise that mathematics educators at all levels should seek to develop in their students.

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

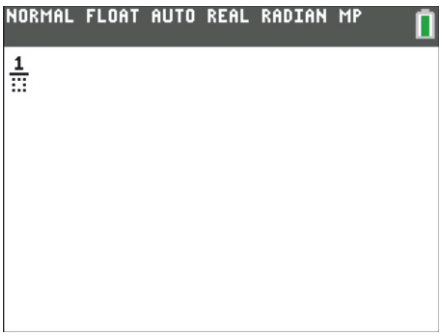
As you work through these investigations, think which Mathematical Practice(s) are highlighted. In terms of content, think where these investigations fit into your curriculum.

### Investigation 1: Use Stacked Fractions, Scrolling History, and Zoom Features to Investigate Patterns

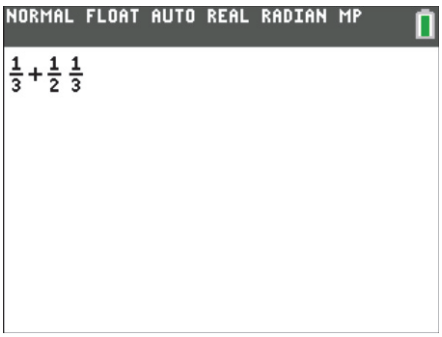
1. Press [1].
2. Press [ALPHA] [F1] to get to the shortcut **FRAC** menu.



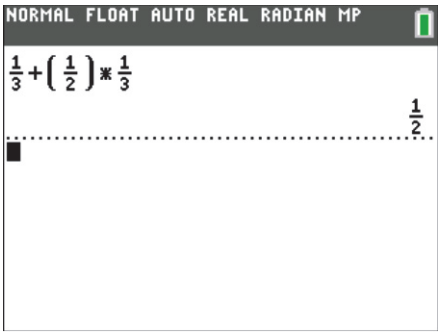

3. Press [ENTER] or [1] to select n/d .



4. Press 3 ▶ + 1 ALPHA [F1] ENTER 2 ▶ 1 ALPHA [F1] ENTER 3 ▶.



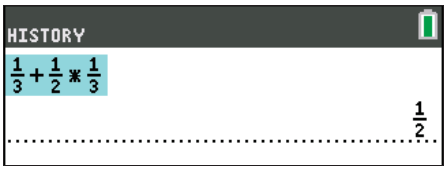

5. Press ENTER.

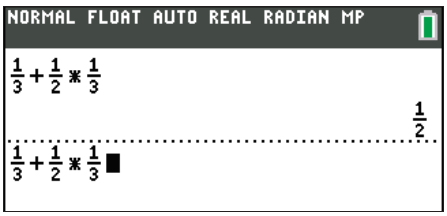


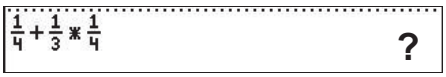

6. Press the ▲ key twice to climb up the history tree and highlight the expression. Press ENTER to copy and paste the expression down to the edit line.

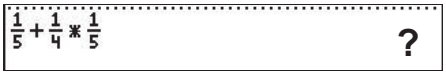
7. Press 2nd ◀ to go to the beginning of the line. Use the arrow keys to change the expression to increase each denominator by 1. Press ENTER.

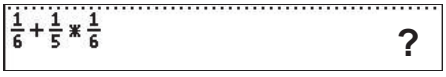
8. Repeat.



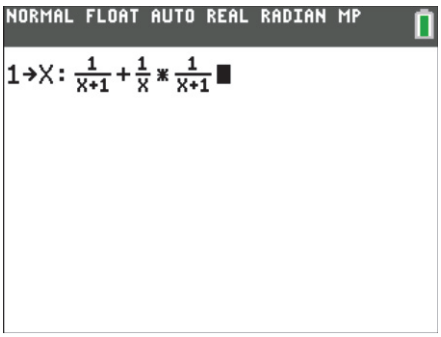



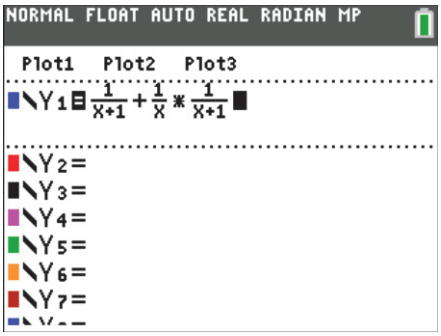
### Questions




1. What pattern do you notice? Will it always work?
2. If you entered $\frac{1}{100}+\frac{1}{99}*\frac{1}{100}$ what would you expect? Confirm your guess.
3. Explore $\frac{1}{x+1}+\frac{1}{x}\cdot\frac{1}{x+1}$ on the home screen for values of *x* of your choice.

   Store a number in *x*: [1] [STO▶] [X,T,Θ,*n*] [ALPHA] [ : ], then scroll through history by pressing the [▲] key twice, press [ENTER] to copy and paste, and replace numbers with variable expressions.

4. Press [2nd] [ENTER] to copy and paste the last entry. Now using [2nd] [◀] , go to the beginning of the line and make *x* any whole number you wish. What do you observe?

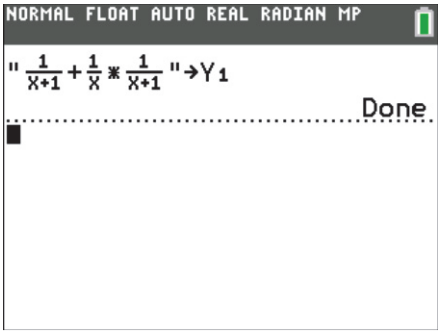



5. Explore the graph of $y=\frac{1}{x+1}+\frac{1}{x}\cdot\frac{1}{x+1}$ . To copy and paste the expression on the Home Screen into Y1, use the delete key so only you have $\frac{1}{x+1}+\frac{1}{x}\cdot\frac{1}{x+1}$ on the entry line, and press [ENTER].

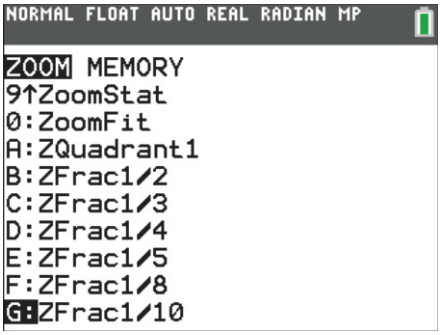
   Press [Y=], position your cursor in Y1, and press [2nd] [ENTER] to paste the expression into Y1.

### Alternate Approach

You can also do this from the home screen, but you must use quotes. Use [ALPHA] [F4] [ENTER] to quickly get Y1.



6. Press [ZOOM] and scroll to see some neat options.

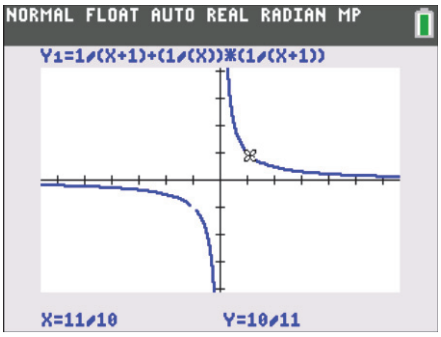



Use ZFrac1/10, press [TRACE], and use the left and right arrow keys.

**Note:** ZFrac1/10 sets the window variables so that you can trace in increments of $\frac{1}{10}$, if possible, and sets ΔX and ΔY to $\frac{1}{10}$.

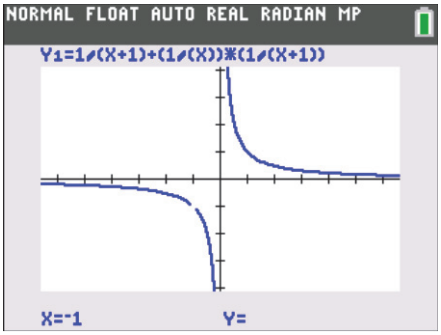
Notice the graph equation at the top of the screen is in classic format. (Instead of a stacked fraction, n/d is shown as a thick bar inline fraction.)

Compare the graph coordinate values as you trace.



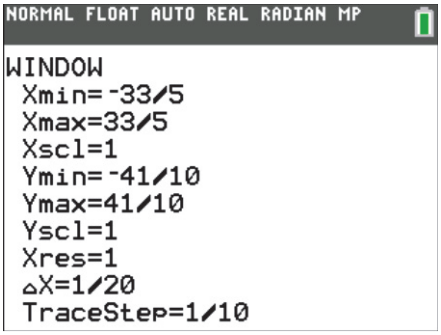

What is happening when $x = -1$?

Press [GRAPH] to exit Trace.




Press [WINDOW], and scroll to notice that ΔX can be modified. ZFrac1/10 uses thick bar inline fractions for Xmin, Xmax, Ymin, Ymax, and ΔX.

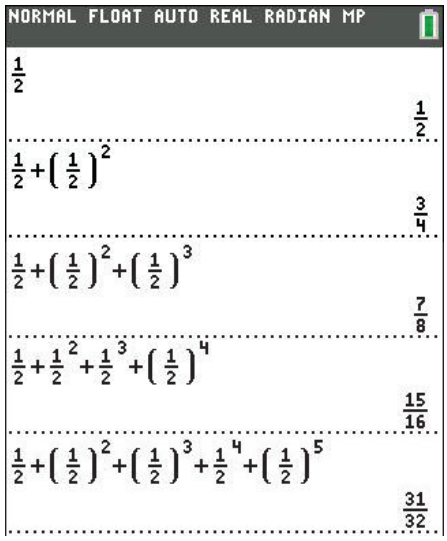
ΔX is the distance between the pixels and TraceStep is the increment used during Trace. TraceStep is always 2ΔX. Changing one changes the value of the other.




7. Get a common denominator and show $\frac{1}{x+1}+\frac{1}{x}\cdot\frac{1}{x+1}$ is algebraically $\frac{1}{x}$.

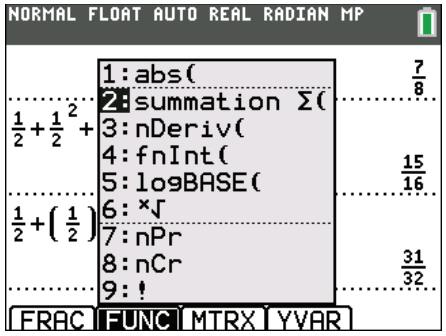
## Investigation 2: Scroll Through the History to Build the Sum of a Sequence

1. Using the scrolling history, the series below can be built.




   a. Create these expressions on your home screen. Use n/d once, and there is no need to use the parentheses keys.

$$\frac{1}{2}$$
$$\frac{1}{2} + (\frac{1}{2})^2 =$$
$$\frac{1}{2} + (\frac{1}{2})^2 + (\frac{1}{2})^3 =$$
$$\frac{1}{2} + (\frac{1}{2})^2 + (\frac{1}{2})^3 + (\frac{1}{2})^4 =$$
$$\frac{1}{2} + (\frac{1}{2})^2 + (\frac{1}{2})^3 + (\frac{1}{2})^4 + (\frac{1}{2})^5 =$$



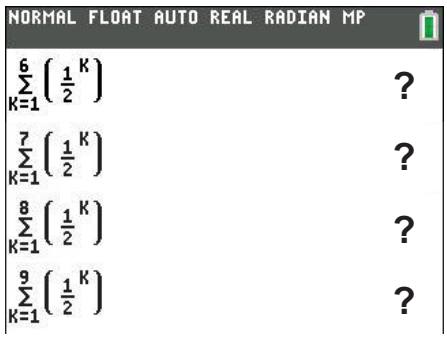

   b. Can you predict the next one?

   What pattern do you see with the total sums?

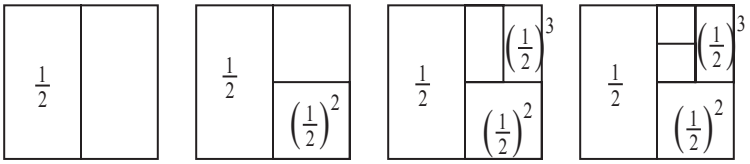
   - Is the sum getting bigger or smaller?
   - Is the number being adding each time getting bigger or smaller?
   - Is the sum approaching a number? Explain your answer.

   Optional: Make four more expressions using sigma notation using the ALPHA [F2] shortcut:

$$\sum_{K=1}^{6}\left(\frac{1}{2}^K\right)$$




   c. How is this geometric model related to this investigation?



2. Pose new questions and make conjectures:

   Use the same pattern as the one used above and investigate the sums in the same manner.

   a. Suppose your first number for finding sums was $\frac{1}{3}$ instead of $\frac{1}{2}$.

   b. Try the same investigation with $\frac{1}{4}$.

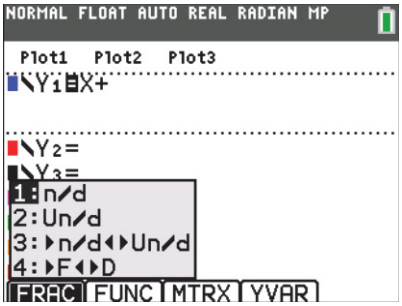
   c. What is the pattern if you use $\frac{1}{5}$?

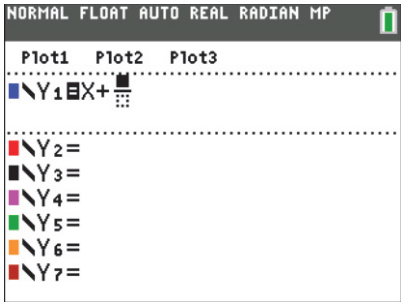
   d. Does a pattern hold for $\frac{2}{5}$?

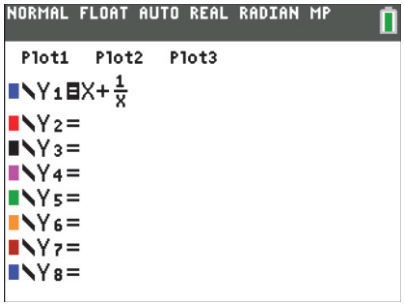
   e. What happens if you use $\frac{3}{2}$?

### Investigation 3: Patterns, Anyone?

1. Enter $x+\frac{1}{x}$ in Y1. For the shortcut FRAC menu, press [ALPHA] [F1].

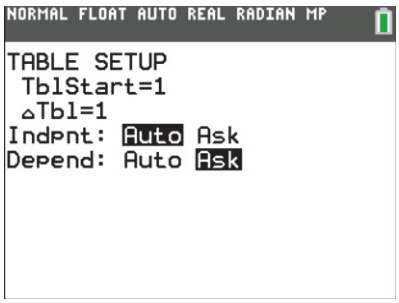


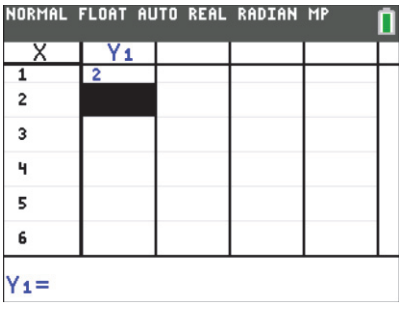



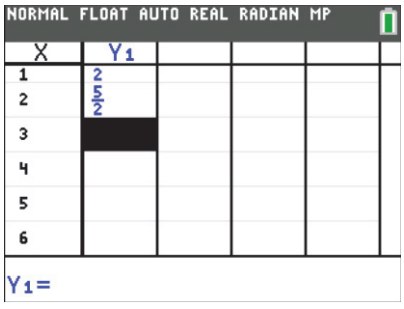



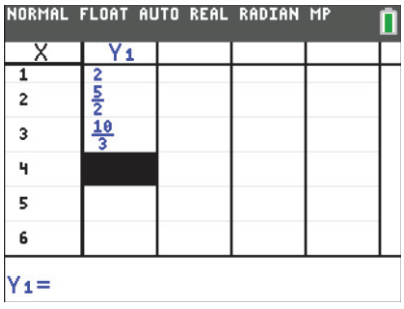

2. Press [2nd] [TBLSET] to set the table to start at 1, climb in steps of 1, automatically display the input, and display the output only when asked.

3. Sit your cursor over the first few outputs and press [ENTER] to display.



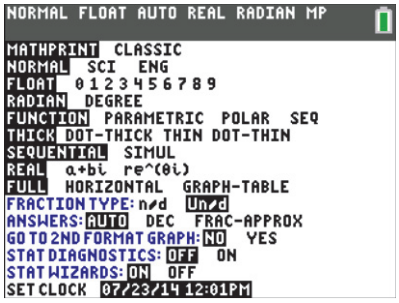
4. Using only the table of values, discuss the following:
   - What do you expect the next value to be?
   - What pattern(s) do you see with the numerators? List as many patterns as you can find.
   - Use the arrow keys and ENTER key to continue the table to see if your prediction is correct.

5. 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?

6. Change the mode to mixed **Un/d**.

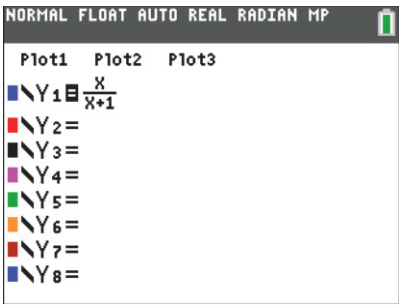
   Press ENTER on each output in the table.

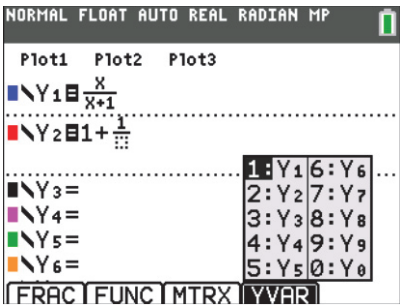
   What connections do you see?

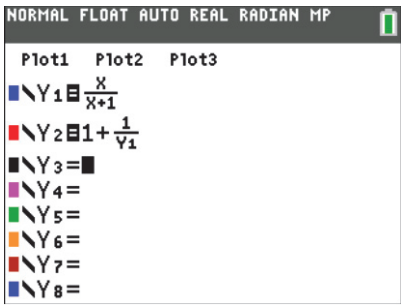



## Investigation 4: More Patterns?

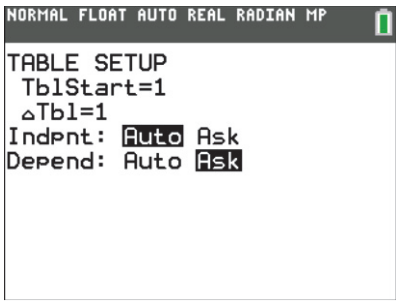
1. Enter $\frac{x}{x+1}$ in Y1. Enter $1+\frac{1}{Y1}$ in Y2. For a shortcut to get Y1, press ALPHA [F4].



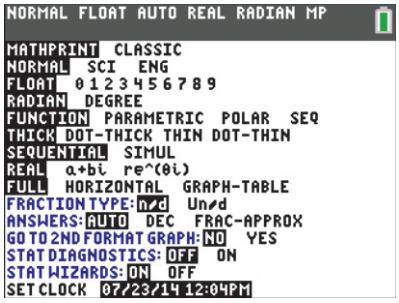



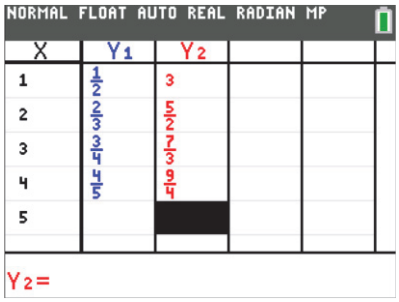

2. Press 2nd [TBLSET] to set the table to start at 1, climb in steps of 1, automatically display the input, and display the output only when asked.



3. Press MODE and select n/d to display improper fractions.




4. As before, place your cursor over the first few outputs in Y1 and Y2 and press ENTER to display.



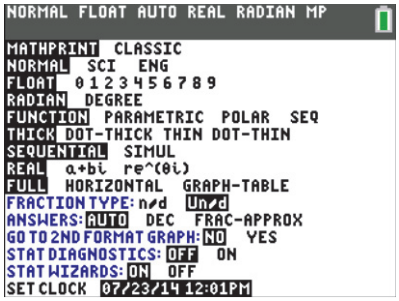

5. Using only the table of values, discuss the following:
   - What do you expect the next value to be?
   - What pattern(s) do you see with the numerators? List as many patterns as you can find.
   - Use the arrow keys and ENTER key to continue the table to see if your prediction is correct.

6. 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?

7. Change the mode to mixed **Un/d**.

   Press ENTER on each output in the table.

   What connections do you see?



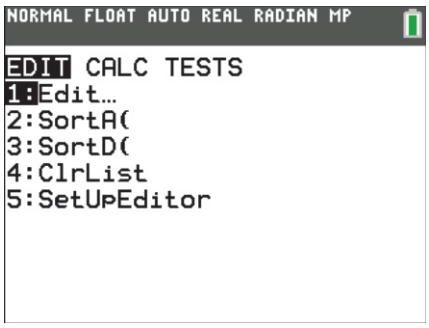

## Investigation 5: Some Problem?

Congratulations! You are offered a job where you are paid 1 measly dollar for the first day, but $2 for the second, $4 for the third, and so on, so that each day's pay is double that of the previous day. How much total will you earn in eight days time? How many days will it take for your total to exceed $100,000?

1. We can make a list which indexes the number of the day, another list for the amount you earned just that day, and a finally a third list for the cumulative sum.

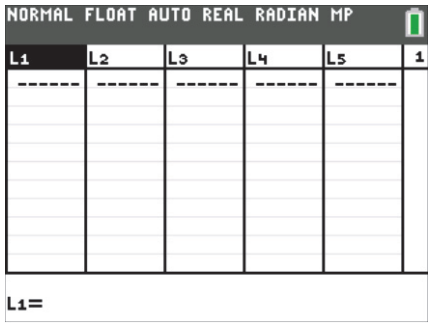
   Press [STAT], followed by 1:Edit to get to the Stat Editor.

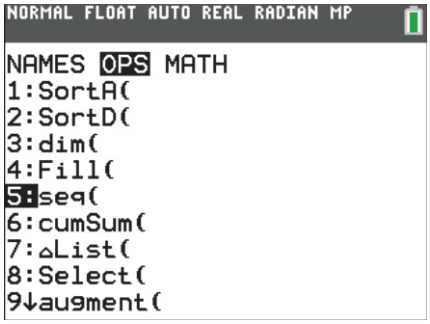
   **Note:** If there is data in the lists you can press [2nd][MEM] 4: ClrAllLists and then [ENTER].



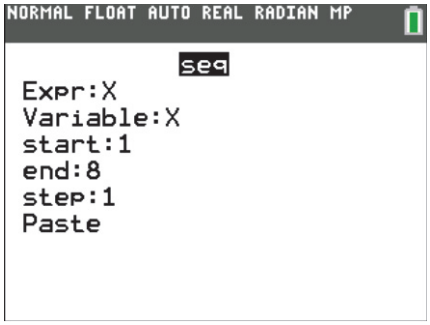

2. Set your cursor on L1 (as shown) to make a sequence {1, 2, 3, …., 8} by pressing [2nd][LIST]>OPS and 5: seq( .

   .

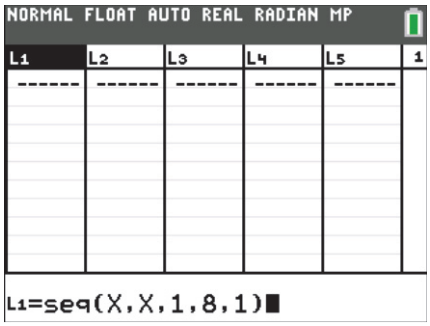


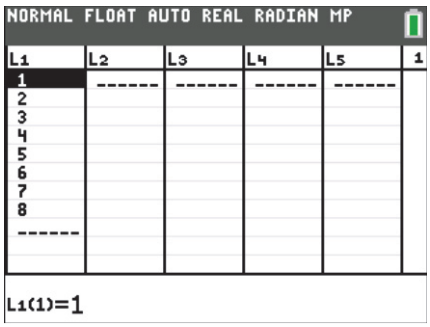

3. The seq( wizard appears. Once the settings to the right are entered, highlight Paste and press [ENTER].



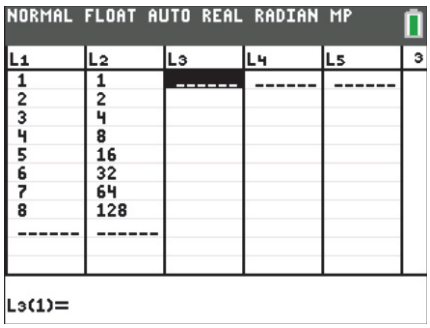

   - This builds and inserts the command into the L1 entry line.



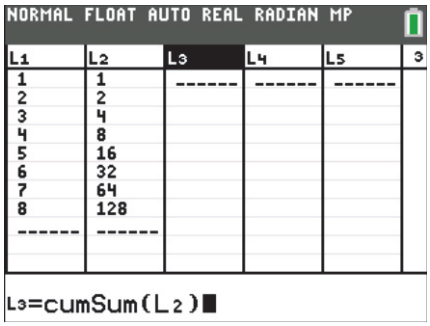
- Press ENTER once more to enter the results in the list.



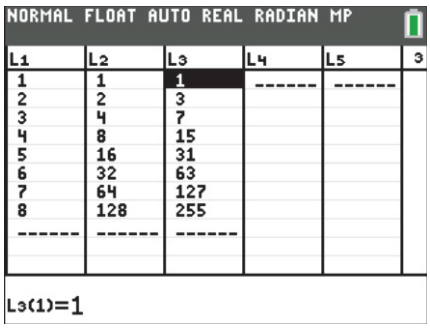

4. Build L2 to give the amount earned each day.




5. Build L3 which gives the cumulative sum. Set your cursor on L3. Press 2nd[LIST] > OPS and 6: cumSum( followed by 2nd[L2] ENTER.




6. The table shows how much he earns on the 8th day as well as how much he has earned overall.
7. How would you modify step 2 to be able to answer the second part of the question?



## Content Connections in Algebra and Precalculus for Investigation 5

- Reasoning from the table (L1, L2), students may see that on day *n* the amount *D* earned that day would be $D = 2^{n-1}$. Along with a plot of data, other students may see that it can be modeled by the formula $D = a \cdot b^n$ with growth factor $b = 2$ and vertical intercept $a = \frac{1}{2}$, so $D = \frac{1}{2} \cdot 2^n$, which is equivalent to $D = 2^{n-1}$ by laws of exponents.

  The total (cumulative) sum *S* earned is a linear function of the amount earned that day, *D*, so $S = mD + b$. The average rate of change or slope $m = 2$ and the vertical intercept $b = -1$.

  Therefore $S = 2D - 1$.

  By substitution:
  $$\begin{aligned} S &= 2D - 1 \\ &= 2(\tfrac{1}{2} \cdot 2^n) - 1 \\ &= 2^n - 1 \end{aligned}$$

  The solution to $100{,}000 = 2^n - 1$ can be found through the table, graph, or analytically with logs.

- On day 8 the total earned is the sum $S = 2^7 + 2^6 + 2^5 + 2^4 + 2^3 + 2^2 + 2 + 1$.

  Students who have studied computers or base two arithmetic might recognize the base two representation of *S* as $11111111_2$, which is a byte of 1's.

  If we add 1 to *S*, we have $S + 1 = 100000000_2 = 2^8 = 256$.

  So $S = 2^8 - 1 = 255$.

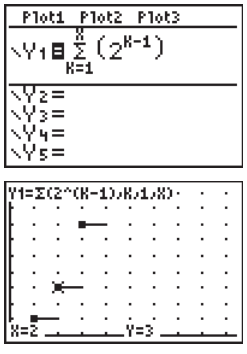
- Precalculus students who have studied geometric series and sigma notation could use another approach. On the *n*th day, the cumulative sum is $S = 1 + 2^1 + 2^2 + \ldots + 2^{n-1}$, a series of *n* terms.

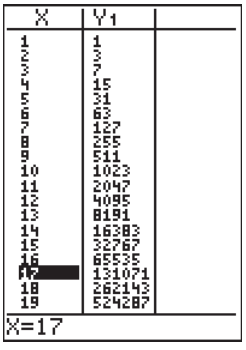
  This could be written in sigma notation $S = 1 + 2^1 + 2^2 + \ldots + 2^{n-1} = \sum_{k=1}^{n} 2^{k-1}$

  We can enter this directly into Y1 and use a table solution.

  Observe what happens if you graph Y1.

  We could also derive its sum to show this formula is $S = 2^n - 1$:



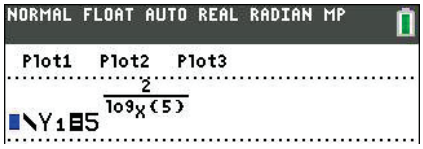

$$\begin{aligned} S &= \sum_{k=1}^{n} 2^{k-1} = 1 + 2^1 + 2^2 + \ldots + 2^{n-1} \quad \text{Bye!} \\ 2S &= \quad 2^1 + 2^2 + \ldots + 2^{n-1} + 2^n \\ -\ S &= 1 + 2^1 + 2^2 + \ldots + 2^{n-1} \\ \hline 2S - S &= -1 \qquad\qquad\qquad + 2^n \\ S &= 2^n - 1 \end{aligned}$$

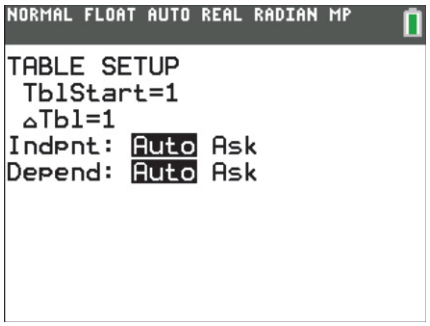
- It may surprise students to find when the sum will exceed 1 million, 1 billion, then 1 trillion, etc.
- Compare the above investigation with the question: *Find the sum of all of the positive divisors of 128*. $128 = 2^7$ and has factors 1, 2, $2^2$, $2^3$, $2^4$, $2^5$, $2^6$, and $2^7$.

  The sum is $S = 2^7 + 2^6 + 2^5 + 2^4 + 2^3 + 2^2 + 2 + 1$.

### Investigation 6: Exploring Logarithms - Part 1

1. Exploring expressions of the form $a^{\frac{b}{\log_x a}}$
2. Insert the expression in Y1 with $a = 5$ and $b = 2$.
3. Set up the table as shown.
4. Press 2nd [TABLE].



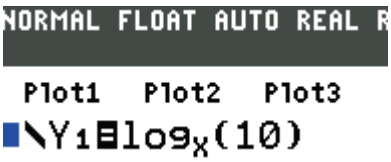

Explore and discuss:

- What happens when you change the parameter *a* to any positive number greater than 1?
- What happens when you change the parameter *b* to 3? to 1? to 0?
- Use properties of logarithms to explain.

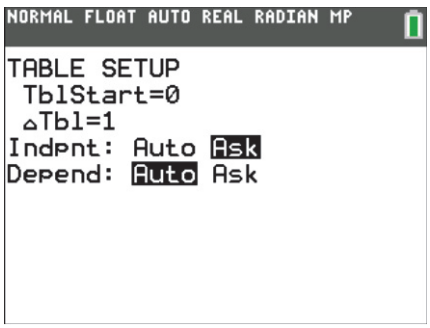
  Hint: Take the logarithms to the base *x* of both sides of the equation $y = a^{\frac{b}{\log_x a}}$.

### Investigation 7: Exploring Logarithms - Part 2

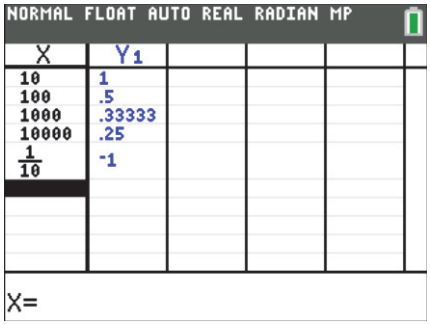
1. Consider the function $y = \log_x 10$. Enter the expression in Y1.




2. Press 2nd [TBLSET] to match the screen shown to the right, where Indpnt is set to Ask.



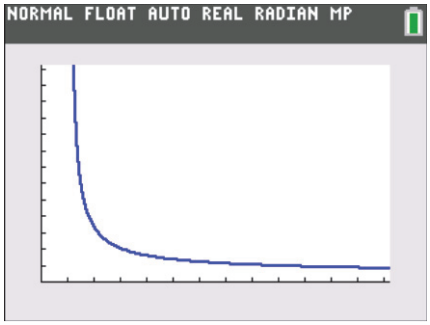
3. Explore with a table, where *x* is a power of 10. Enter powers of ten in the X column and press ENTER.




**Discuss:**

- For the first four entries of the table, how is the denominator of the output related to the number of 0's of the input?
- What relationship holds for negative integer powers of 10, such as $\frac{1}{10}, \frac{1}{100}$, etc.?

4. Explore with a graph in a ZQuadrant1 Window.




5. Rewrite the function $y = \log_x 10$ so that *x* is not the logarithmic base.

   **Hint:** Let $y = \log_x 10$, write in exponential form, and then take common logarithms of both sides of the equation. Compare tables and graph the result in the same window.

6. Follow up: In general, does $\log_a b = \frac{1}{\log_b a}$?

   **Hint:** Let $y = \log_a b$, solve for *b*, then take logarithms of both sides to the base *b*.

## Additional Resources

The Common Core State Standards: http://www.corestandards.org/Math/Practice/

To access assessment items which address Common Core Mathematical Practices see the *Partnership for Assessment of Readiness for College and Careers* (PARCC)

http://www.parcconline.org/samples/math

and the *Smarter Balanced Assessment Consortium*

http://www.smarterbalanced.org/sample-items-and-performance-tasks/.

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# One-Variable Statistics

**TI PROFESSIONAL DEVELOPMENT**

## Activity Overview

*This activity provides an opportunity to collect and analyze one-variable data.*

### Concepts

- One-variable data
- Measures of central tendency
- Measures of variability
- Box plots
- Histograms

### Compatible TI Technology

- TI-84 Plus CE
- TI-84 Plus C Silver Edition
- TI-84 Plus Silver Edition
- TI-84 Plus

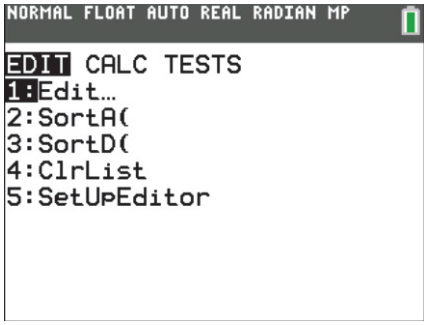
### Materials

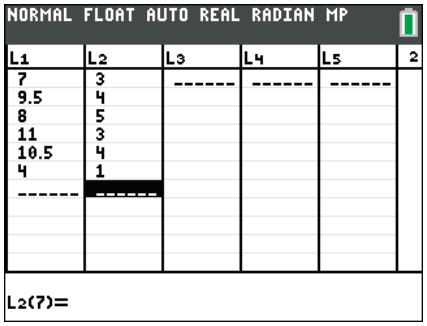
- Optional: string, scissors and rulers, meter sticks or tape measures.

## One-Variable Data

Collect your favorite one-variable data—height, shoe size, years of teaching experience, letters in your last name, distance from home, etc.

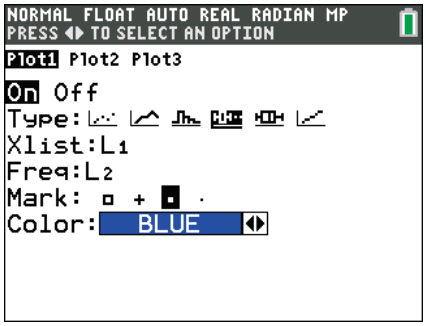
1. Press [STAT], and choose 1:Edit.
2. Enter the values into L1 as they are called out. If appropriate, enter Frequency in L2.
3. Estimate the mean, median, and mode; record your estimate.
4. In a hallway, long room, or outdoors, create a "human box plot" of one of these data sets as everyone lines up in a single file arrangement from minimum value to maximum value.
   - Determine the median, lower quartile, and upper quartile by identifying the positions of the people.
     - Who is in the middle?
     - Who is in the middle of the lower half?
     - Who is in the middle of the upper half?
     - What data value does each of these people have?
   - Optional: Use string or meter sticks to mark the median and quartiles.
5. Now create a human histogram by "stacking" rather than by being in single file.



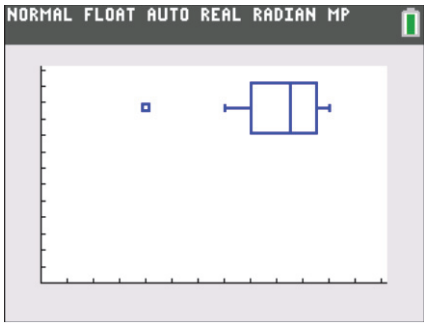




In the Screen above, Shoe Size is in L1 and Frequency is in L2.

6. Return to the classroom, and create a box plot in **Plot1**.

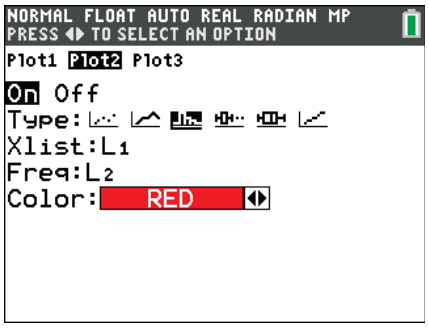



- Press [2nd] [STATPLOT] and select Plot1.
- Choose an appropriate viewing window. Press [GRAPH].

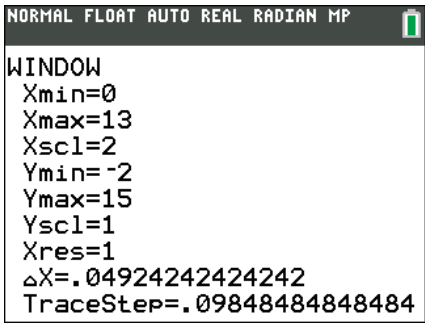



- Press [TRACE] and [▶] and [◀] to view the median, quartiles, minimum, and maximum.
- In the Screens to the right, participants' Shoe Size is in L1 and Frequency is in L2 from the sample data.

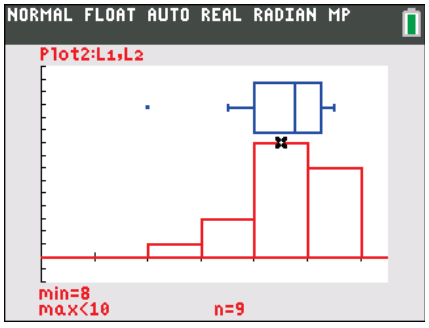
7. In **Plot 2** create a histogram for the data.




- In a histogram, the Xscl setting in WINDOW determines the width of the bars (or the range of scores in the bars). You will receive an error if you choose an impossible value.

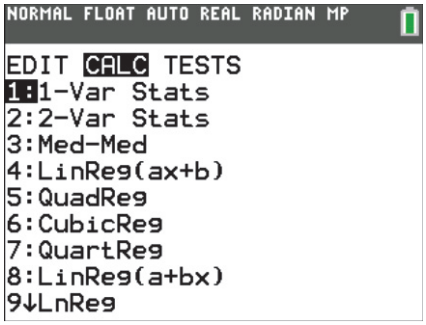



- Press [GRAPH].
- Press [TRACE] and [▶] and [◀] to view the frequencies.
- Press [▼] and [▲] to move from the histogram to the boxplot.

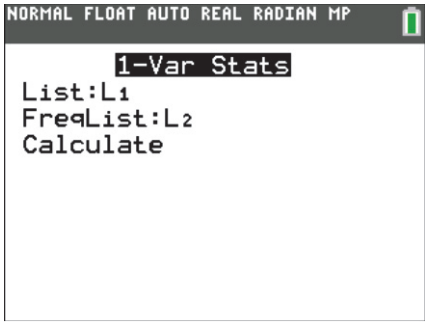


8. Perform one-variable statistics on the data set.

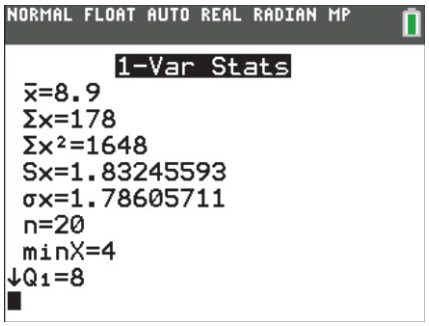
   - Press [STAT], press [▶] to reach the CALC menu, and press 1:1-Var Stats.

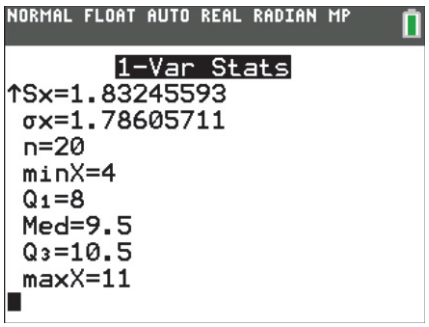



   - Enter values, highlight **Calculate** press [ENTER].

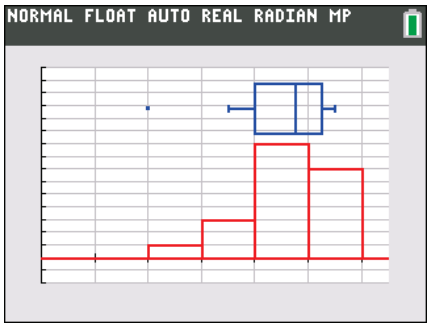



   - The statistics are shown at the right. Press the down arrow to view the five number summary at the bottom.




Note: The use of gridlines might enhance the display of the box plot and histogram.



# Let's Collect Some Data

1. How many letters are there in your first name? _____

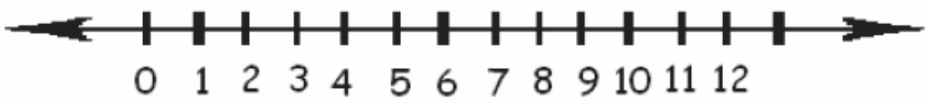
2. How many letters are there in the first names of your classmates?

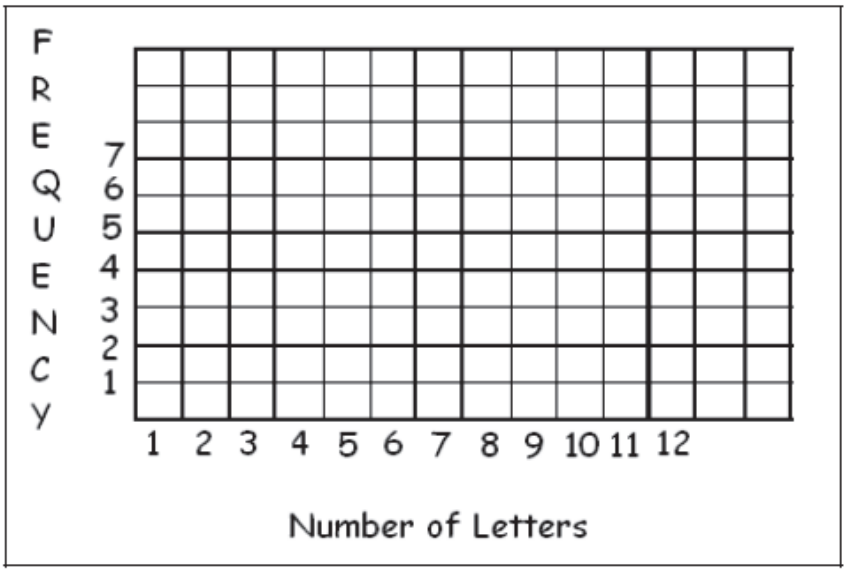
| | | | | |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |

3. Enter the data into L1 in the calculator and calculate the following:

- The minimum _____
- The maximum _____
- The mean _____
- The median _____
- The mode _____
- The range _____
- Lower quartile _____
- Upper quartile _____

4. Create a box plot on the number line below and a histogram on the grid below.




5. Create a box plot and histogram with the TI-84 Plus C Silver Edition.

6. Create a series of questions to go along with this activity.

# Exploring the Coordinate Plane

**TI PROFESSIONAL DEVELOPMENT**

## Activity Overview

*In this activity, we will explore the coordinate plane by graphing a square using an x-y line plot.*

### Concepts

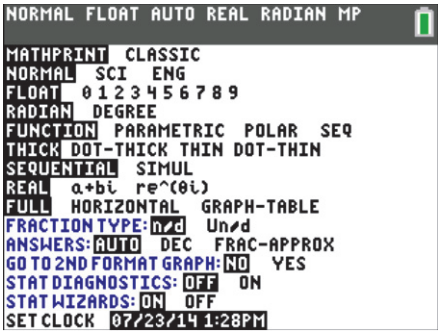
- Entering ordered pairs in lists
- Coordinate graphing
- Standard window
- Decimal window
- Fractional windows

### Materials

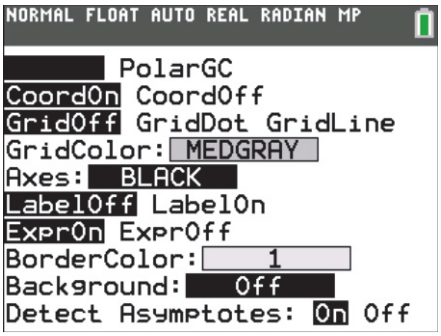
- TI-84 Plus CE
- TI-84 Plus C Silver Edition
- TI-84 Plus Silver Edition
- TI-84 Plus

### Create Decimal and Fractional Windows

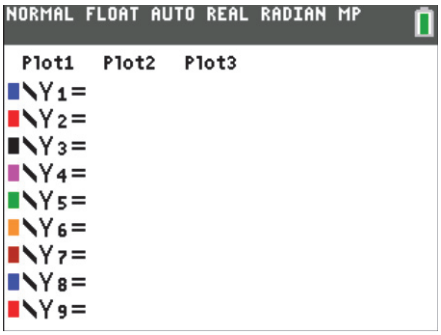
1. Make sure the settings on the TI-84 Plus CE are shown as on the screen to the right.
   - Press [MODE].




   - Press [2nd][FORMAT] or use the shortcut GO TO 2ND FORMAT GRAPH on the MODE Screen. Configure as shown.

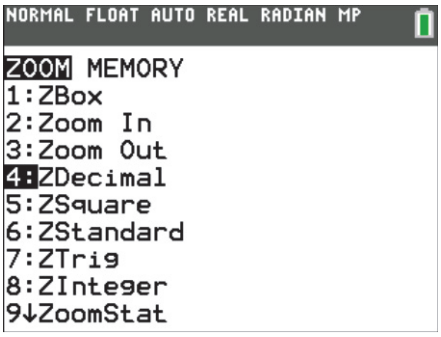


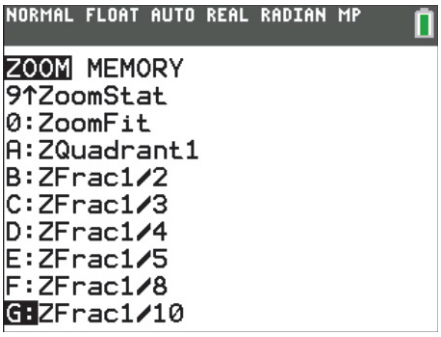

   - Press [Y=]. Clear or deselect any equations and turn off all plots.



- A shortcut is to press [2nd] [MEM], 7:Reset.., then 2:Defaults…, then 2:Reset.


2. Press [ZOOM] followed by 4:ZDecimal.
   - Use the arrow keys to explore the screen.
   - Press [WINDOW]. What is ΔX? This is a decimal window.
   - Press [ZOOM] followed by G:ZFrac1/10 and repeat the above.
   - What has changed? What is the same?
   - This is a Fraction window using a TraceStep of 1/10. Explore other fractional windows.
   - Why are these be called “friendly windows”?



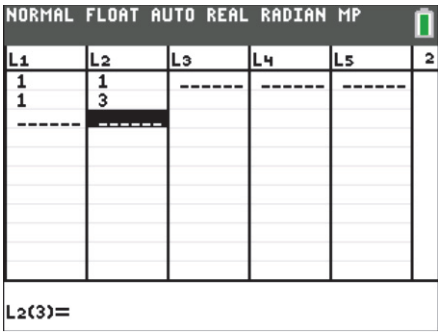




### Create an Integer Window

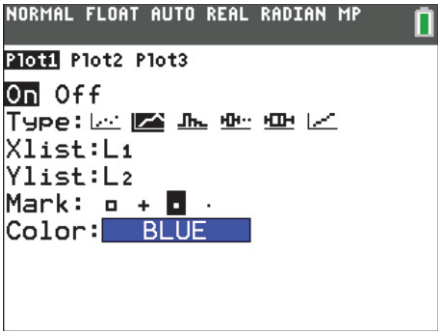
3. Press [ZOOM] 4:ZDecimal or 6:ZStandard followed by [ZOOM] 8:ZInteger.
   - Press [ENTER]. Use the arrow keys to explore the screen.
   - Press [WINDOW]. What is ΔX? This is an integer window.

### Plot Points to Make a Square

4. Enter the *x*-coordinates of the points (1, 1) and (1, 3) in L1 and the *y*-coordinates in L2.

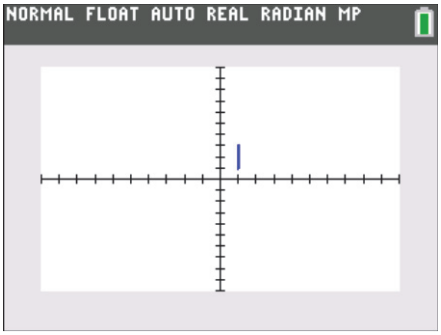


5. Set up a Stat Plot as shown.

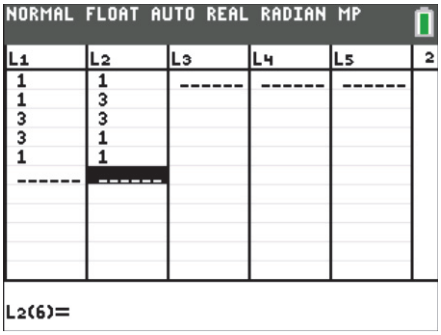



6. Set a standard window by pressing ZOOM 6:ZStandard.

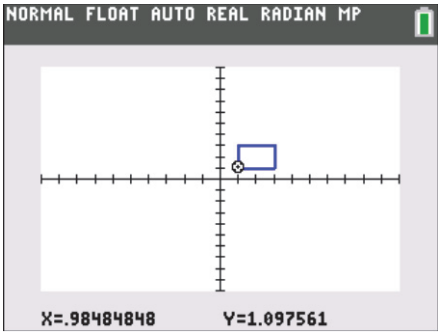
   - What are the coordinates of the two remaining vertices of the square in Quadrant 1 with side length equal to that of the given line?



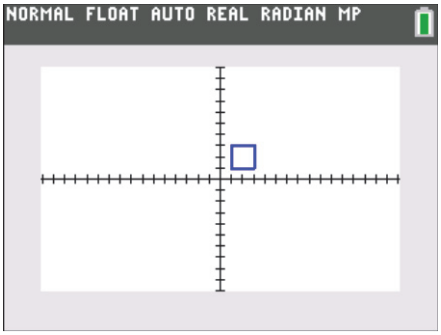

7. Enter the coordinates of the vertices of the square into L1 and L2. Repeat the first coordinates at the end of the lists so that the figure will be closed.



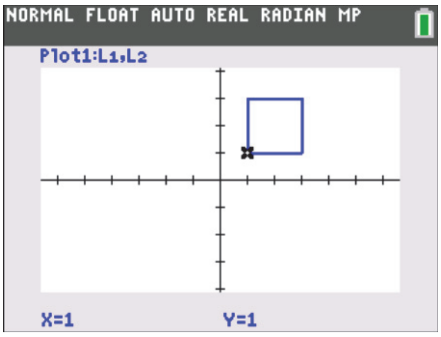

   - Press GRAPH.
   - Use the free-floating cursor to examine points on the square.
   - Compare with using TRACE to examine the data points.



8. In a standard window, both horizontal and vertical tick marks are 1 unit apart, but the horizontal tick marks look farther apart than the vertical tick marks. Consequently, graphs and figures will not have a true geometric perspective. One way you can correct this is to make this a "square window."
   - Press [ZOOM] 5:ZSquare.




9. Another way you can correct this is to use a pre-set window which is already square.
   - Press [ZOOM] followed by 4:ZDecimal.
   - Also try Zoom G:ZFrac1/10.
   - Use the free floating cursor to examine the points on the square. Compare with using [TRACE].
   - Explore the other pre-set fractional windows Zoom A:ZQuadrant1, Zoom B:ZFrac1/2, … etc.
   - Which of these pre-set windows are both friendly and square?



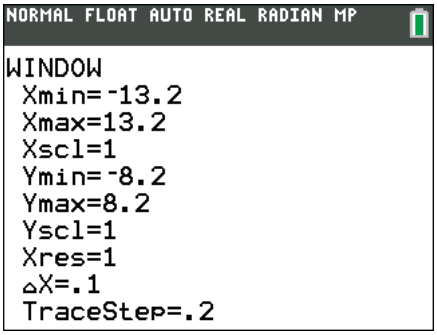

## A Geometry Activity

### Introduction

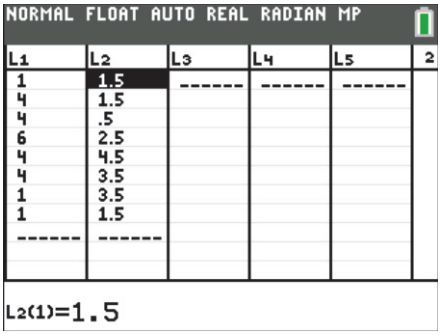
In geometry, we can reflect, rotate, translate, and dilate a figure. In this activity, lists and statistical plots on the TI-84 Plus CE will be used to illustrate and explore the relationships.

### Setup

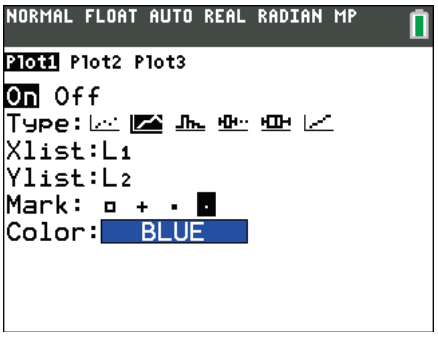
1. Set your window so that the values for min and max on both *x* and *y* are double what they would be in the ZDecimal window.



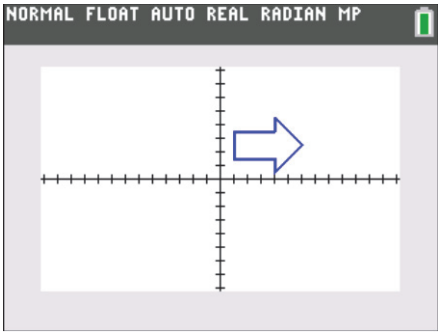
2. Enter the coordinates in L1 and L2 as shown.




3. Set up the Stat Plot using a connected LinePlot and the smallest mark so the points won't show up in the figure.

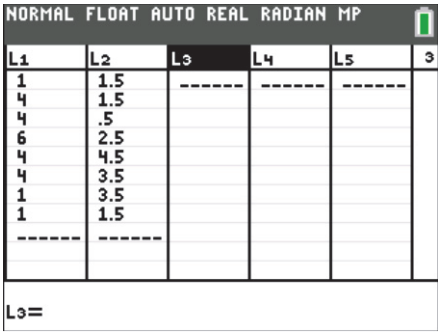



4. Press GRAPH.

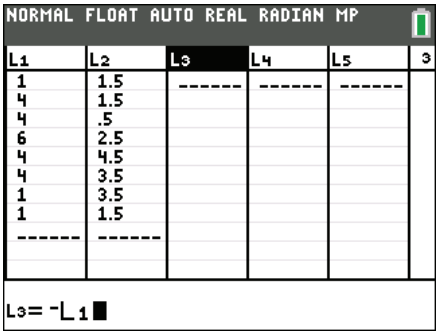



## Special Reflections

1. In the statistics editor, move to the column heading for L3. Be sure you are at the top of the column.

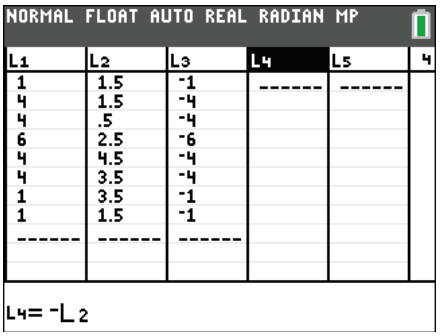


2. Type (-) 2nd [L1] to assign −L1 to L3. Press ENTER.

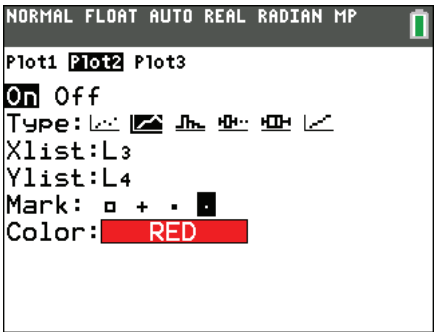



3. Likewise, move to the column heading for L4 (at the top of the column) and type (-) 2nd [L2] to assign –L2 to L4. Press ENTER.

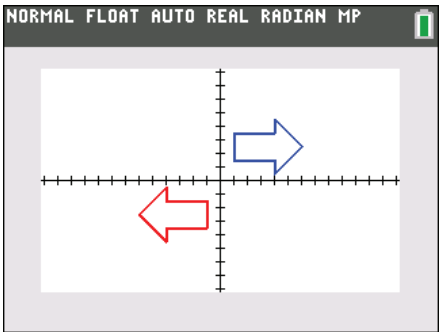
   This will give you the negative *x* values in L3 and the negative *y* values in L4.




4. Set up the Stat Plot as shown.




5. Press GRAPH. This produces a ‘Symmetry’ through the origin. It is a reflection in one axis followed by a reflection in the other axis. It may also be known as a ‘point reflection’.



6. To create reflections, you can explore with different combinations of L1, L2, L3, and L4.

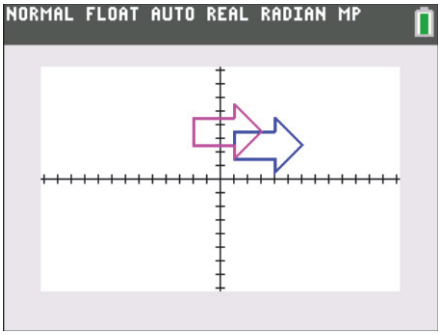
   Students could be asked to draw these by hand and by using the TI-84 Plus CE to emphasize the skills.

| | Ordered Pair | Lists (*x* then *y*) |
|---|---|---|
| Original image: | (*x*, *y*) | L1 vs. L2 |
| | (-*x*, *y*) | L3 vs. L2 |
| | (*x*,-*y*) | L1 vs. L4 |
| | (-*x*, -*y*) | L3 vs. L4 |
| | (-*y*, *x*) | L4 vs. L1 |
| | (-*x*,- *y*) | L3 vs. L4 |
| | (*y*,- *x*) | L2 vs. L3 |
| | (*y*, *x*) | L2 vs. L1 |

Some reflections may also look like rotations.

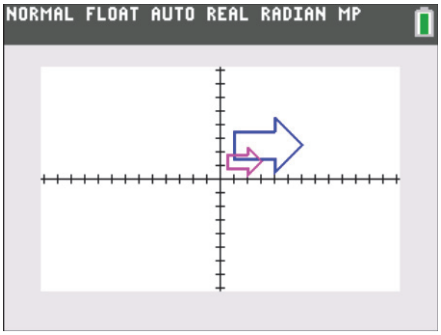
Other terms such as symmetry and dilation might also be used appropriately.

## Translations




1. To translate a figure horizontally, you need to add or subtract from the *x*-values.
2. To translate a figure vertically you need to add or subtract from the *y*-values.
3. Go to the column heading for L5, and assign L1−3 to L5. Type [2nd] [L1] [−] [3] and press [ENTER].
4. Go to the column heading for L6, and assign L2 + 1 to L6. Type [2nd] [L2] [+] [1] and press [ENTER].
5. Create another plot using L5 as the *x*-values and L6 as the *y*-values. There will be an image shifted left 3 units and up 1 unit.

## Dilations

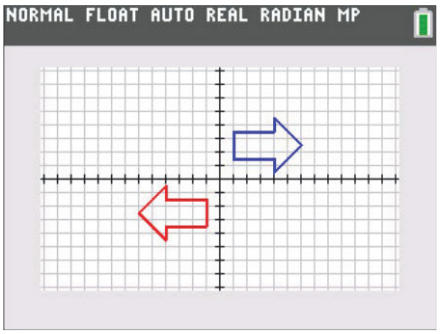



1. To dilate a figure horizontally, the *x*-values must be multiplied by a scaling factor, and likewise to dilate it vertically the *y*-values must be multiplied by a scaling factor.
2. In the column heading for L5, type 0.5L1.
3. In the column heading for L6, type 0.5L2.
4. The plot of L5 vs. L6 should be a reduction of 50% of the original.

What happens if you use *different* scaling factors?

## Extension Ideas

1. Have students design their own image, and move through the transformations to create “artwork.”
2. Explore rotations. This requires Trigonometry, but is a useful extension if appropriate.
3. Play ‘Match My Image.’ Have students explore until they match your new image.
4. Find areas and perimeters of the pre-images and images and compare.




The use of gridlines may aid in the finding of the areas and perimeters of the shapes.

# Pass the Ball
## Student Activity

Name _____
Class _____

### Objectives

- Graph scatter plots
- Graph linear functions
- Analyze proportional relations
- Interpret, predict, and analyze data and graphs

### Compatible TI Technology

- TI-84 Plus CE, TI-84 Plus C Silver Edition, TI-84 Plus Silver Edition, TI-84 Plus

### Materials

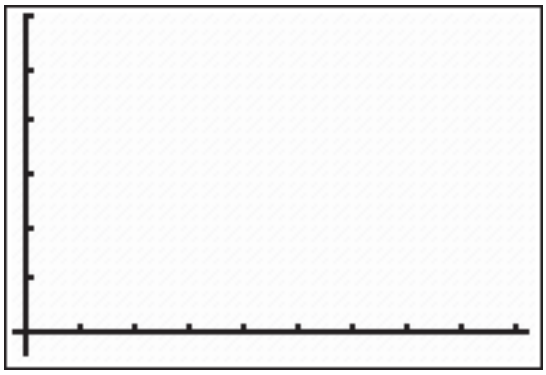
- Stopwatch and small bouncing ball (tennis/racquet balls work well)

| Number of People | Trial 1 | Trial 2 | Trial 3 | Average Time in Seconds |
|---|---|---|---|---|
| 4 | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

1. Fill in the table above.

2. Estimate how long you think it will take to do this activity with everyone in the room participating.

3. Enter the number of people in the group in **L1** and the time for that group to pass the ball in **L2**.
   - Turn on the [STAT PLOT] for **L1** and **L2** using the **9:ZoomStat** feature from the [ZOOM] menu to scale your window.
   - Make a sketch of these data points in the graph to the right.



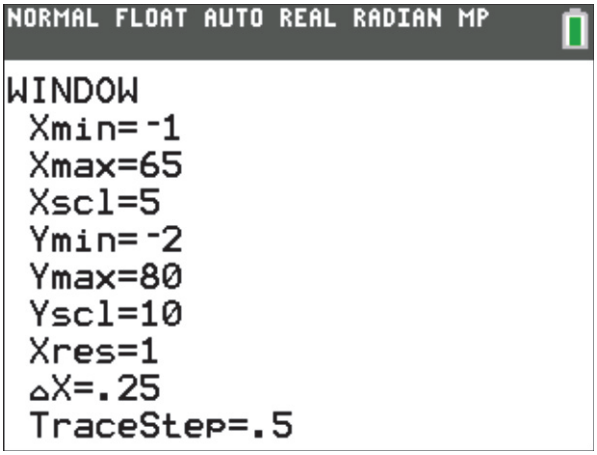
4. Draw what you consider to be a line of best fit.

**Pass the Ball**
**Student Activity**

**Name** _____
**Class** _____

5. Select two data points through which your line passes and use them to find the slope of your line.
   - Write the equation of your line here_____, enter it into the calculator beside **Y1 =**, and then press GRAPH.
   - Examine how closely the line you drew matches the line on your calculator.

6. It may be helpful to take control of the window settings rather than staying with the **9:ZoomStat** setting.
   - Press WINDOW.
   - Adjust the spread on the *x*-values to be a multiple of 47 as shown here to assure yourself of "friendly" numbers when scrolling.
   - Next, adjust the *y*-values to include the approximation of the time you expect the entire class will take to pass the ball.




7. Press TRACE, and use the down arrow key to trace along the line **Y1**, not the data points.
   - Move to the right until your *x*-value matches the total number of students in your class.
   - Record your *y*-value of that point here and explain what it represents.

   *y* = _____

8. Turn off **Plot 1**, and clear **Y1** before beginning the Extension activity.

# Pass the Ball
## Student Activity

Name _____
Class _____

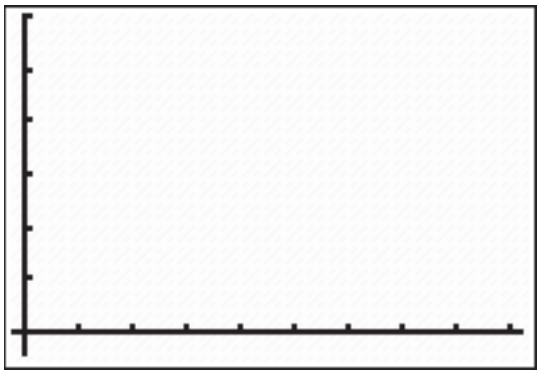
### Extension Activity 1

1. Fill in the table below.

| Number of People | Trial 1 | Trial 2 | Trial 3 | Average Time in Seconds |
|---|---|---|---|---|
| 4 | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

2. Estimate how long you think it will take to do this activity with everyone in the room participating.

3. Enter the number of people in **L3** and the time for passing the ball in **L4.**
   - Turn on the [STAT PLOT] for **L3** and **L4**.
   - Use the **9:ZoomStat** feature from the [ZOOM] menu to scale your window.
   - Make a sketch of these data points in the graph to the right.



4. Draw what you consider to be the line of best fit.

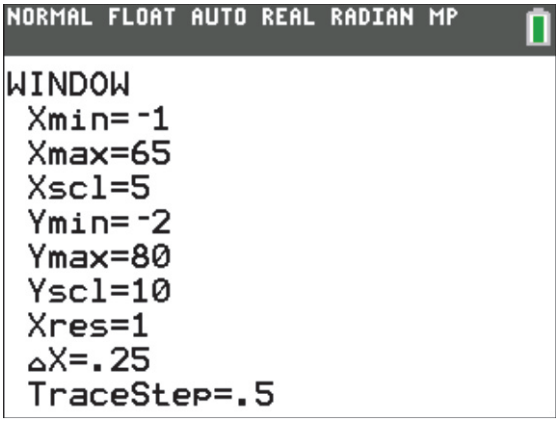
5. Select two points through which your line passes and use them to find the slope of your line.
   - Write the equation of your line here_____, enter it into the calculator beside **Y1 =**, and then press [GRAPH].
   - Examine how closely the line you drew matches the line on your calculator.

# Pass the Ball
## Student Activity

Name _____

Class _____

6. It may be helpful to take control of the window settings rather than staying with the **9:ZoomStat** setting.
   - Press WINDOW.
   - Adjust the spread on the *x*-values to be a multiple of 47 as shown here to assure yourself of "friendly" numbers when you scroll.
   - Next, adjust the *y*-values to include the approximation of the time you expect the entire class will take to pass the ball.




7. Press TRACE, and use the down arrow key to scroll along the line entered in **Y1,** not the data points.
   - Scroll to the right until your *x*-value matches the total number of students in your class.
   - Record your *y*-value of that point here and explain what it represents.

   *y* = _____

8. Was your approximation for the time it took the entire class an exact match to the time you recorded from actually doing the activity?

   What could be the cause of any discrepancy?

# Pass the Ball

**TI PROFESSIONAL DEVELOPMENT**

**TEACHER NOTES**

## Activity Overview

*Many things in everyday life follow patterns. Mathematics can be used to examine the patterns that occur in a specific scenario and then predict future events for that scenario. This activity includes two examples of such patterns. The data collected is the time it takes to complete a task. The data will be used to make predictions about how long it will take to repeat that same task a certain number of times. The timed task is passing a ball. The basic concept has relevance to many areas of math, science, and everyday life.*

## Objectives

- Graph scatter plots
- Graph linear functions
- Analyze proportional relations
- Interpret, predict, and analyze data and graphs

## Compatible TI Technology

- TI-84 Plus CE, TI-84 Plus C Silver Edition, TI-84 Plus Silver Edition, TI-84 Plus

## Materials

- Stopwatch and small bouncing ball (tennis/racquet balls work well)

1. For this activity, begin by having four students stand in a circle.
   - The starter will bounce, catch, and pass the ball to the next person.
   - Continue bouncing, catching, and passing the ball until it is back to the one who started.
   - Explain to students the importance of working at a consistent pace rather than working too quickly.

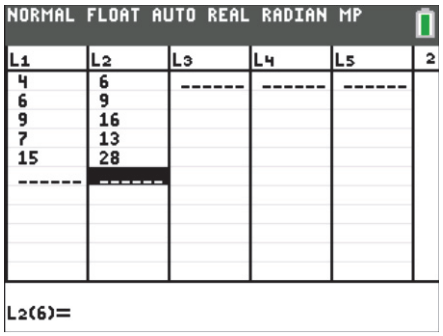
2. Time how long it takes the ball to get all the way around the circle.
   - Start and stop with the same person.
   - Have students record three trials of this process on their worksheets and calculate the average time.
   - Have them record the average in the chart on their worksheet.

| Activity Sample Data | |
|---|---|
| **Number of People** | **Average Time in Seconds** |
| 4 | 6 |
| 6 | 9 |
| 9 | 16 |
| 7 | 13 |
| 15 | 28 |

3. Complete the table for five different sets of students.
   - There should be a different number of students for each set.
   - To maximize participation, do not allow the same student to be in more than one group.

4. For the last row in each table, have everyone in the room participate.
   - Before timing this trial, have students predict how long they think it will take and write it on their worksheet.
   - Ask them to share their predictions.
   - Then time the trial for the entire class.

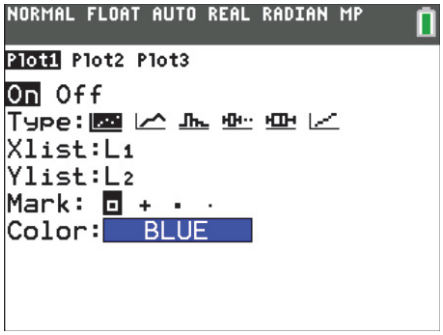
5. Press [STAT] [ENTER] to access the Stat List Editor window.




- Have all students enter the data in L1 and L2. Do NOT include the data for the trial that included the entire class.
- Have one student enter the data on the presentation calculator.

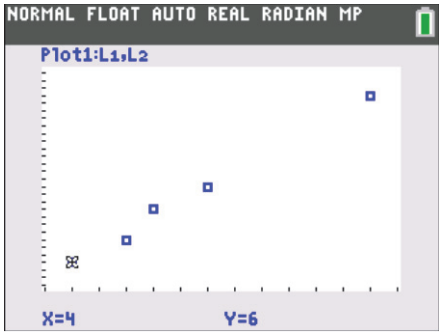
## Data Analysis

6. Create a scatter plot.




- Press [2nd] [Y=] to access the [STAT PLOT] menu.
- **1: Plot 1** will be highlighted.
- Press [ENTER].
- Use the arrow keys to highlight the On choice, and press [ENTER] to select **On**.
- Continue using the arrow keys to navigate through this screen and adjust it as shown in the screen shot.

7. Press [ZOOM], and select **9:ZoomStat** by pressing [9] or by scrolling down until it is highlighted and pressing [ENTER].

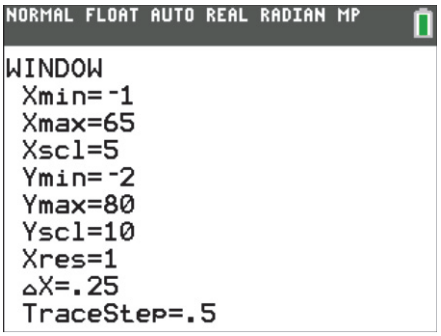



- This feature automatically adjusts the size of the graph window to include all the data points.
- When the scatter plot is displayed, press [TRACE], and scroll right and left to see the coordinates of each point displayed below the graph.
- Notice the **Plot1** in the upper left corner.
- This tells you it is tracing the points from **Plot1**, and displays the lists that are the coordinates of the plot.

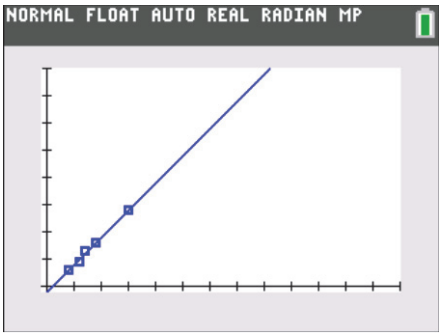
8. Have students fit the data with a function rule. There are several ways you can do this depending on your students' understanding of linear functions and features of the calculator. Below are three suggestions. Choose the one most appropriate for your students. Linear Regression and Manual-Fit Features are taught in subsequent lessons.

- Use the Linear Regression feature of the calculator.
- Use Manual-Fit feature of the calculator.
- Use paper and pencil to sketch a line of best fit, and find its equation.

The directions here will be for this last option.

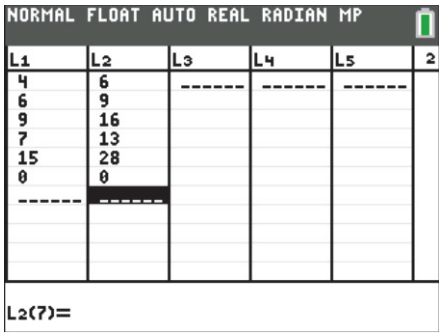



a. It may be helpful to take control of the window settings rather than staying with the **9:ZoomStat** setting.
   - You can assure yourself of "friendly" numbers (without a lot of places after the decimal point) when you scroll if the spread on the *x*-values is a multiple of 66 as shown.
   - Expand the *y*-values to include the approximation of the time you expect the entire class will take to pass the ball.




b. Have students sketch their points in the screen provided on their worksheet. Next, have them sketch their approximation of the line of best fit.

c. After sketching the line on their worksheet, direct students to find an equation and enter it in Y1 of the Y= window.
   - To do this, have them identify two points and use their *x*- and *y*-values to determine the slope of the line.




d. Discuss with your students why the point (0, 0) would be a point that should be included with this data.
   - How many minutes did it take for no students to pass the ball?
   - Add the (0, 0) point to your data lists.
   - Since it is likely that the points do not lie in a straight line, have students work in groups and have each group choose two points from the lists.
   - Have each group choose a different set of points. One possible answer is (28–6)/(15–4) = 2.

e. Using this slope, have students write the equation of the line in Y1 and compare their lines with each other. Have them graph the line to determine if their lines fit the plotted points.

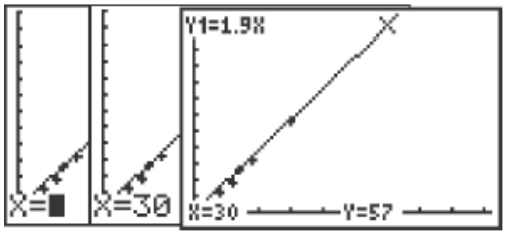
9. Have students use either the trace or table feature to predict how long they would expect it to take the entire class to complete the activity. Discuss how close their predictions were to the actual time it took the whole class and possible reasons for any discrepancy.

10. Another option for predicting the time it took the entire class to pass the ball is to have the calculator find the *y*-value for a given *x*-value.

    - From the graph screen, press [2nd] [TRACE] to access the [CALC] menu.
    - **1:Value** is highlighted already, so just press [ENTER].
    - An X= is displayed in the bottom left-hand corner.
    - Enter the value for the total number of students in the class, and press [ENTER].

    **Note**: The value you enter must be included in the domain that was set in the [WINDOW] screen.

    The corresponding *y*-value will be displayed, and a cursor will mark the ordered pair on the graph.




### Extension Activity 1

1. Repeat the process, but this time pass the ball without first bouncing it. A list of sample data is shown.

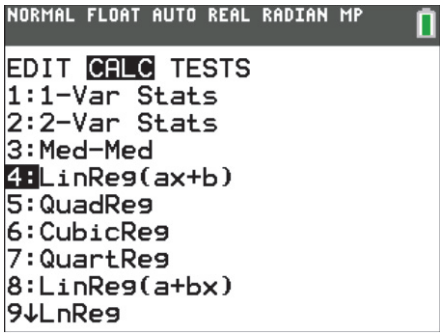
2. After finding the regression equation and entering it into **Y1**, solve a problem that requires a prediction for values that are beyond the values in the recorded data.
   For example, "If it took 50 seconds, how many people were there?"

| Extension Sample Data | |
|---|---|
| **Number of People** | **Average Time in Seconds** |
| 5 | 3.98 |
| 7 | 4.91 |
| 9 | 6.42 |
| 11 | 8.54 |
| 15 | 11.93 |

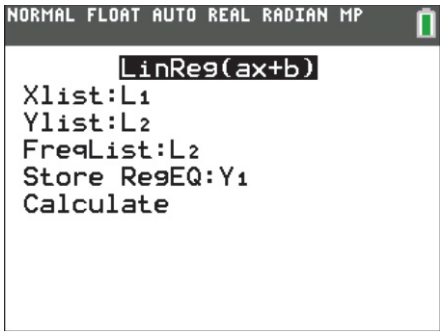
3. The equation of the line for the sample question would be 50 = *mx*. If the slope was found to be 0.787, the equation becomes 50 = 0.787*x* and $x \approx 64$ people.

## Extension Activity 2

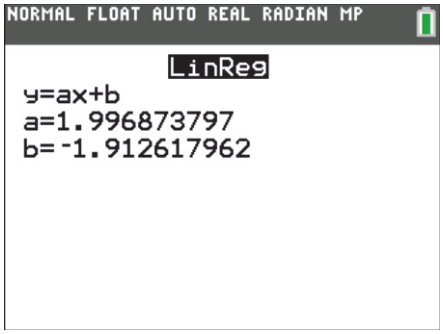
1. To use the calculator's regression feature to get the best fit model, press [STAT], arrow to CALC, and select 4: LinReg(ax+b).



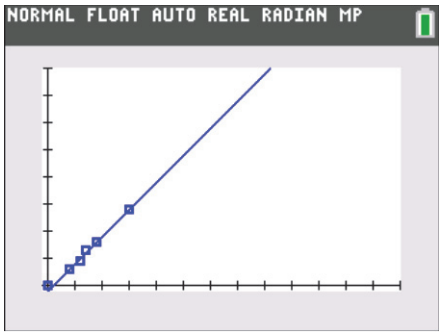

2. Press [ENTER] and the LinReg Wizard will open. Configure as shown. To access L1 andL2 press [2nd] [L1] and [2nd] [L2].
   - To access Y1, Press [ALPHA][F4] to choose where to store the equation.
   - Highlight Calculate and Press [ENTER].




3. The regression model will be displayed on the home screen.



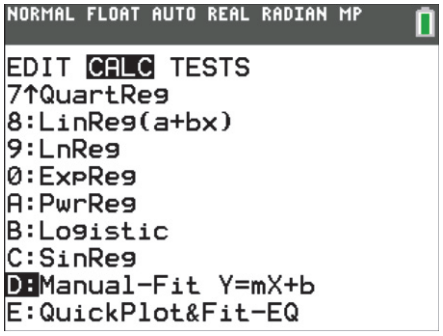

4. Press [GRAPH] to see the model and the scatterplot.



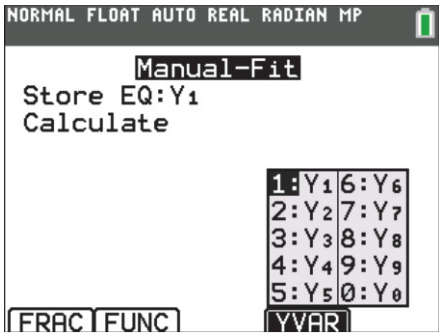
## Extension Activity 3

1. Clear out the current Y1 equation. To use the calculator's Manual-Fit feature to get the best fit model, press [STAT], choose CALC, scroll to D: Manual-Fit Y=mX+b, and press [ENTER].

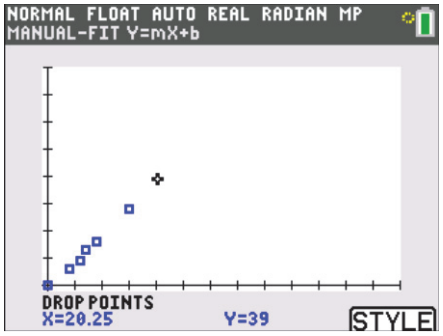
   Note: More information on **Manual-Fit Y=mX+b** is given in Appendix D.



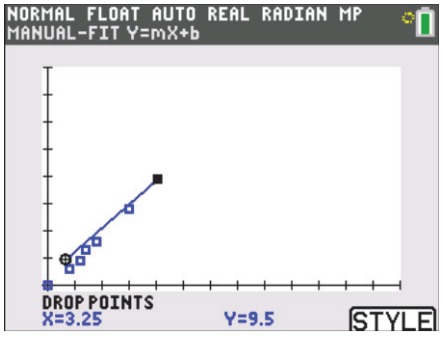

2. Press [ALPHA][F4] to choose where to store the equation. Choose Y1, highlight Calculate, and press [ENTER].



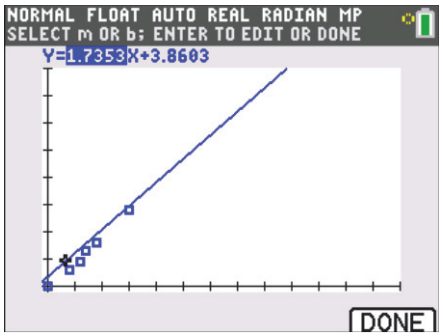

3. When you get the next screen, use the arrow keys to move the cursor to your first point and press [ENTER] to drop it.



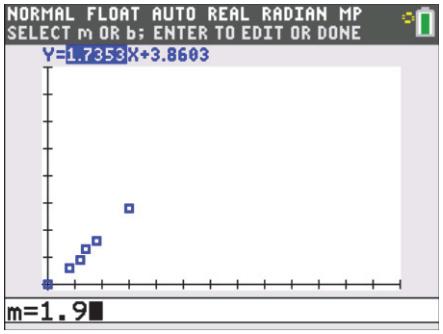

4. Press the arrow keys to create a line to model the data.



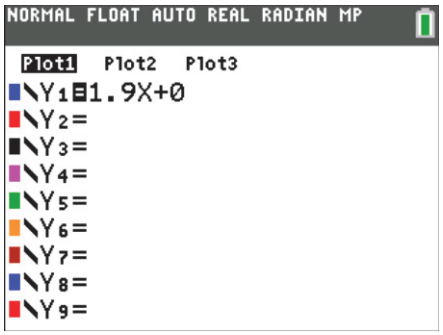
5. Press [ENTER] to set the end point. The graph will appear.



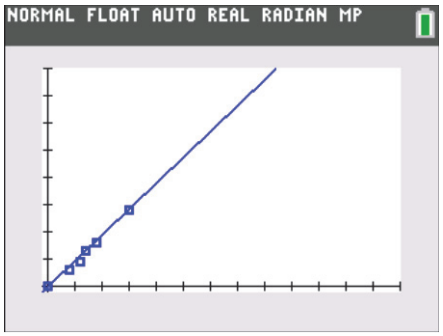

6. Use the left and right arrow keys to switch between the *m* and *b* values. Enter a number and press [ENTER] to change the value. Change *m* and *b* until you are happy with the fit. Then press [2nd] [QUIT] or the **DONE** softkey.




7. Press [Y=] to view your model.




8. Press [GRAPH] to view the model and the scatterplot.



## Discussion Notes

- Guide your students toward an understanding of the concept that a change in the *x*-values will cause a change in the *y*-values.
- Point out that if they were able to all pass the ball at exactly the same pace, they would be simulating a constant rate of change in the *x*-values that would bring about a constant and predictable change in the *y*-values.
- The fact that the estimation from the line of best fit is not an exact match to the actual time measured for the entire class is easily explained by human inconsistencies.
- The approximation from the line of best fit was not exact, but it should have been close enough to allow students to understand how this type of model building and reasoning could be used to predict future events with some reasonable degree of accuracy.

## Worksheet Answers

The answers to the questions on the worksheet will vary depending on the data collected.

# Online Resources

## TI Professional Development

### Activity Overview

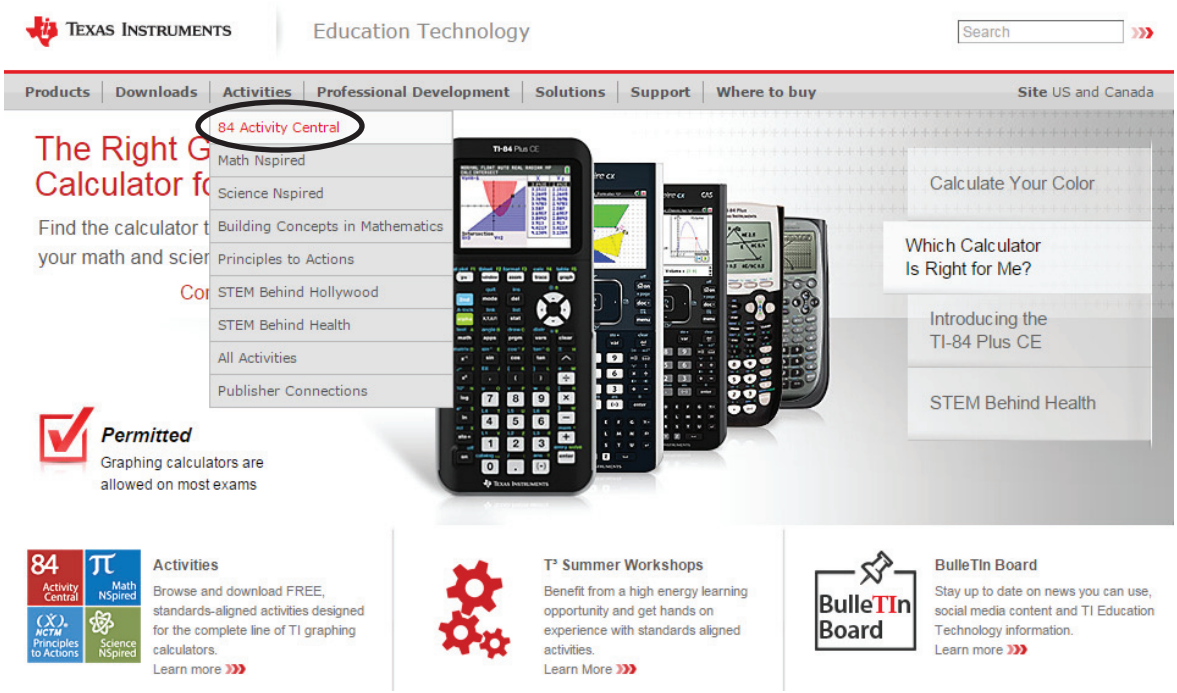
*In this activity, you will explore resources available at education.ti.com. You will browse for activities at 84 Activity Central; search for activities using the Standards Search and Textbook Search; and explore additional information regarding professional development.*

### Materials

- Computer with internet connection

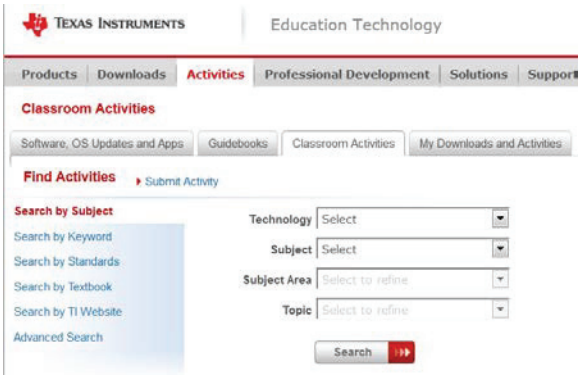
**Step 1:**

Go to **education.ti.com** > **Activities > 84 Activity Central**.




**Step 2:**

After browsing 84 Activity Central, go to **Activities > All Activities**. Search for an activity by Subject, Keyword, Standards, or Textbook.



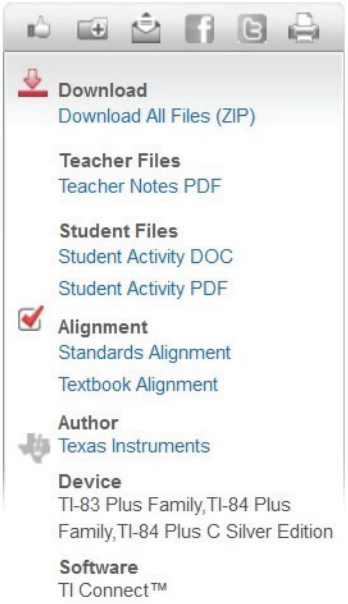
# Online Resources

## TI Professional Development

**Step 3:**

Select an activity from the list. The activity page shows objectives, relevant vocabulary, and additional information. A short video offers a preview of the lesson, and related lessons are recommended below.

Icons above the Downloads section allow you to recommend, save, email, and print an activity. Links to Facebook and Twitter are also available. The Downloads section contains links to activity files. Links for Standards Alignment, Textbook Alignment, and relevant Tech Tip Videos are also available.




**Step 4:**

Go to **Professional Development > Online Learning**.


Explore the **Live Webinars**, **On-demand Webinars** and **Technology Tutorials** links.

**Step 5:**

Explore other resources available at the **education.ti.com** website.

# Getting Started with the TI Connect™ CE Software

**TI PROFESSIONAL DEVELOPMENT**

## Activity Overview

*Teachers and students need a way to back up their graphing calculators, take screen captures, transfer files, and easily update the operating system. The TI Connect™ CE software application makes exchanging information between the TI-84 graphing calculator family and your computer quick and easy. You can use TI Connect™ CE to send files to multiple connected calculators at once, quickly take and manage screen captures, create background images, and create and edit TI Basic programs. The TI Connect™ CE software includes three workspaces – Screen Capture, Calculator Explorer, and Program Editor. In this activity, you will explore the basic features of the TI Connect™ CE software.*

## Materials

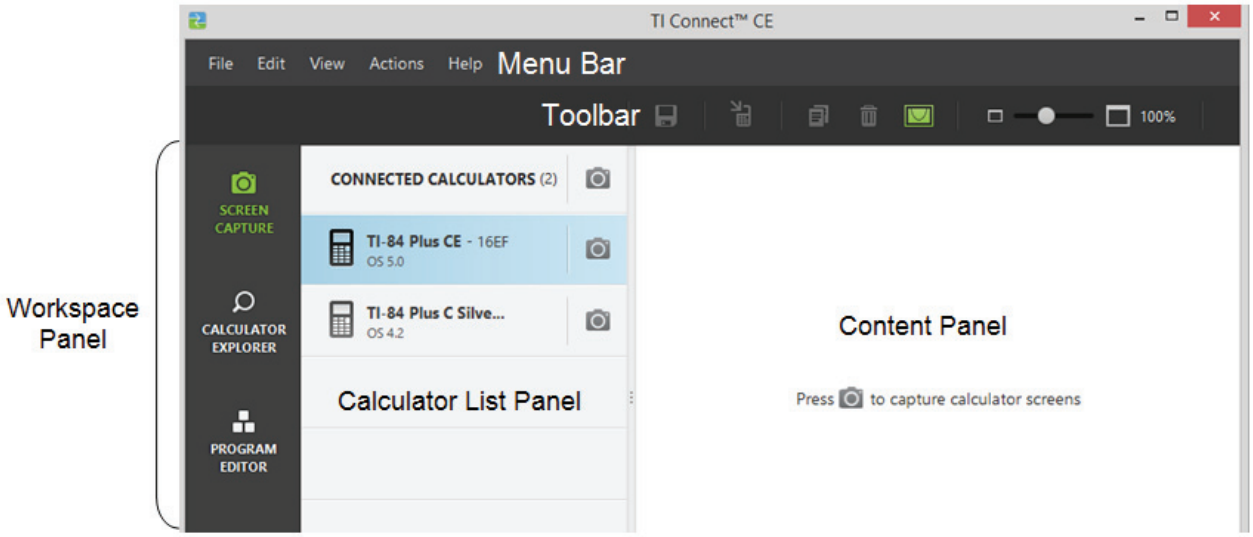
- TI Connect™ CE software, which is available for free at education.ti.com
- TI-84 Plus CE graphing calculator
- Standard-A to mini-B USB cable

**Note:** Although this activity references the TI-84 Plus CE graphing calculator, most functions work with the TI-84 Plus C Silver Edition, TI-84 Plus Silver Edition, and TI-84 Plus graphing calculators.

## Part One – Introduction to the Software

To use the TI Connect™ CE software:

- Connect the TI-84 Plus CE to the computer using the standard-A to mini-B USB cable.
- Turn on the graphing calculator.
- Launch the TI Connect™ CE software on your computer.



## Part Two – Using the Screen Capture Workspace

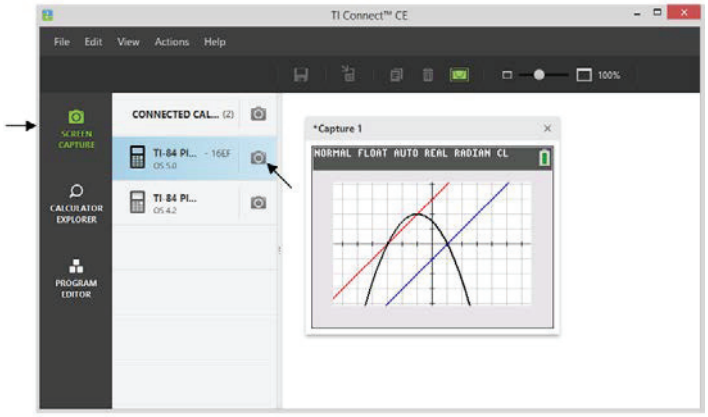
The Screen Capture feature gives the teacher or student an easy way to take and manage screen captures from the connected graphing calculator quickly and simply.

### Capturing Screen Images from the Calculator

With the calculator connected, select the **Screen Capture** Workspace in the TI Connect™ CE software.

### To Capture Calculator Screens

1. Display the screen on your calculator that you want to capture.
2. Click the camera icon next to the desired calculator in the Calculator List.




- You can drag and drop captured images from the Screen Capture workspace into many computer applications.
- Captured calculator images in the Screen Capture workspace can be saved to your computer as a PNG file.

## Part Three – Using the Calculator Explorer Workspace

The **Calculator Explorer** workspace allows the teacher or student an easy way to work with the files on the TI-84 Plus family of graphing calculators. The Calculator Explorer key features related to files are:

- Viewing the contents of the graphing calculator
- Copying calculator files to your computer
- Copying computer files to the connected graphing calculators
- Deleting calculator files
- Backing up and restoring calculator files
- Updating calculator files

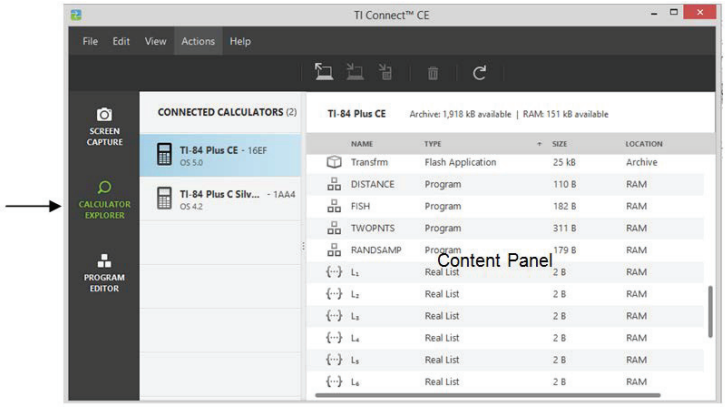
You can copy most data, files, and programs from your calculator to your computer as a content backup, to send to others, or to free up calculator memory.

- The **Calculator Explorer** workspace also enables you to convert images to be used as a background on your calculator.

### A. Exploring the calculator contents

With the calculator connected, select the **Calculator Explorer** workspace in the TI Connect™ CE software.

Make sure that the contents of the connected calculator appear in the Content Panel.

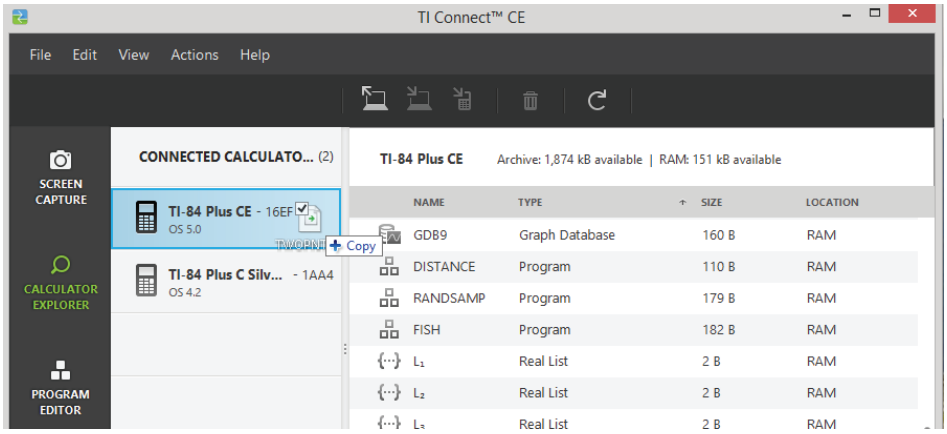


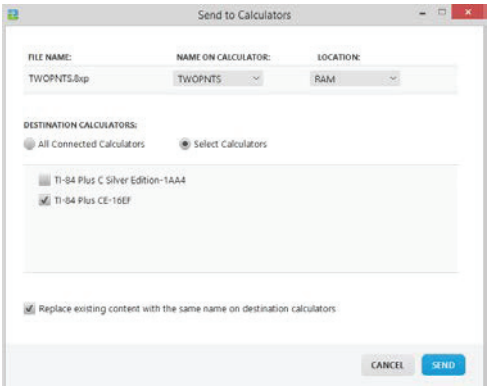

### B. Using “drag and drop” to copy a file from the calculator to the computer

1. Click on the file name to select it.
2. Drag and drop the file into a folder on your computer or onto your desktop.

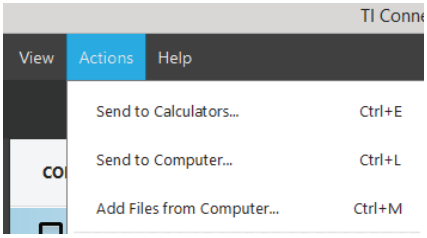
### C. Using “drag and drop” to copy a file from the computer to the calculator(s)

1. Navigate to the desired file on your computer.
2. Drag the file to the Calculator List Panel and hover over the desired calculator.
3. Release the mouse button when you see + Copy
4. Select a file name from the drop-down menu. This will be the name of the program on your calculator.
5. Click Send.



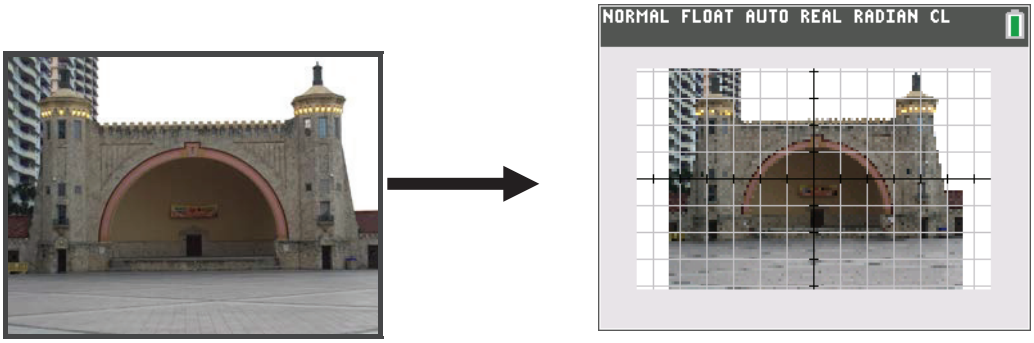



- Options for copying and sending files can be found under Actions on the Menu bar.
- Alternatively, they are also on the Toolbar.
- **Do not disconnect the cable during a transfer.**




### D. Sending a Background Image to a Connected Calculator

**Calculator Explorer** workspace also enables you to convert images to be used as a background on your calculator




With the calculator connected, select the **Calculator Explorer** workspace in the TI Connect™ CE software. Make sure that the contents of the connected calculator appear in the Content Panel.

1. Choose the image file on your computer that you want to convert to a calculator background.
2. Drag the file to the Calculator List Panel and hover over the desired calculator.
3. Release the mouse button when you see 

4. Select an image# name from the drop-down menu (Image0 – Image9). This will be the name of the image on your calculator.
5. Click Send.

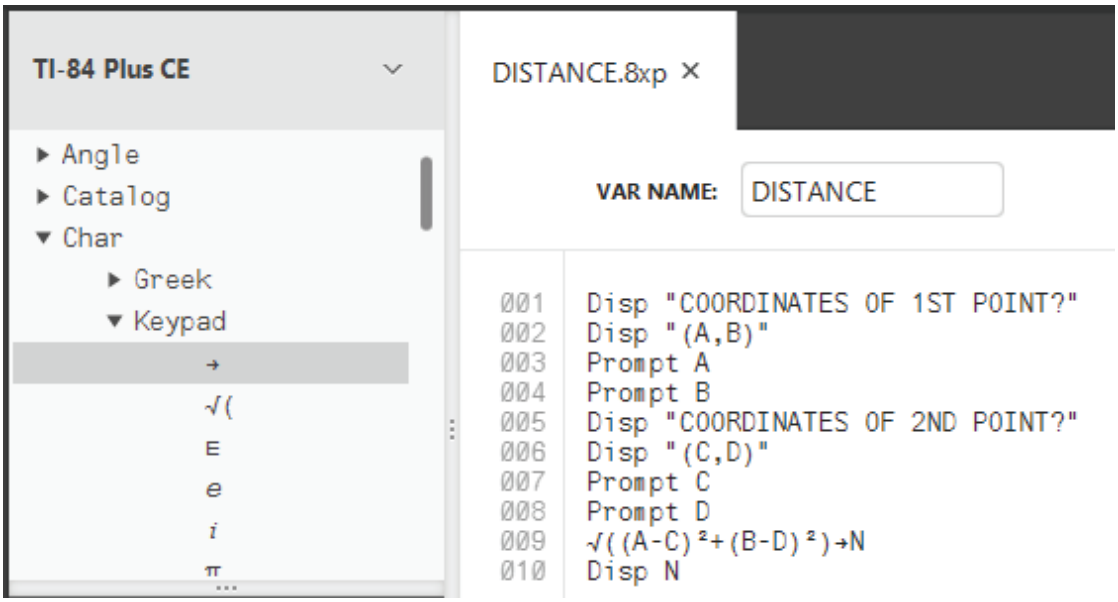
**Keep in Mind:**

- Sending files lets you share your files with others and still maintain a copy on both your computer and your own graphing calculator.
- If multiple calculators are connected to the computer, you can choose to send the file to all connected calculators, or just selected calculators (from a check list).
- Background images are converted and sent from the **Calculator Explorer** workspace.
- **Do not disconnect the cable during a transfer.**

## Part Four – Using the Program Editor Workspace

The **Program Editor** workspace can be used to create and edit calculator TI Basic programs. Additionally, you can quickly send programs directly to your connected calculator(s).

- Use the **Program Editor** workspace to write a program.
- Name and save the program on your computer, and then send the program to your calculator. (A sample program for computing the distance between two points in the coordinate plane is shown below.)
- **Do not disconnect the cable during a transfer.**




Optional: Checking the box next to the lock icon before saving and sending will protect the program from being edited on the handheld.

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# Getting Started with the TI-SmartView™ CE Emulator Software

TI PROFESSIONAL DEVELOPMENT

## Activity Overview

*You will explore features of the TI-SmartView™ CE emulator software for the TI-84 Plus Family. The TI-SmartView software gives you the complete functionality of the TI-84 Plus CE, the TI-84 Plus C Silver Edition, and the TI-84 Plus graphing calculators on your computer. The software contains additional functionality that can be used to enhance presentations and classroom demonstrations.*

## Materials

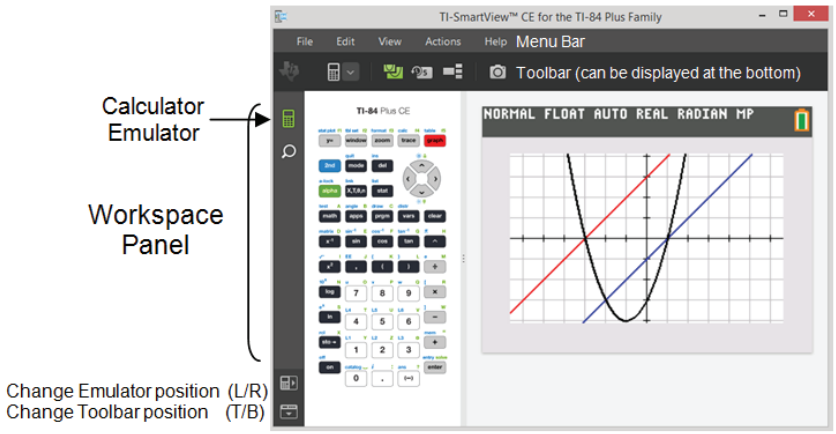
- TI-SmartView™ CE emulator software

**Note:** Although the TI-84 Plus CE is used throughout this activity, the TI-SmartView CE software contains three emulators: TI-84 Plus CE, TI-84 Plus C, and TI-84 Plus.

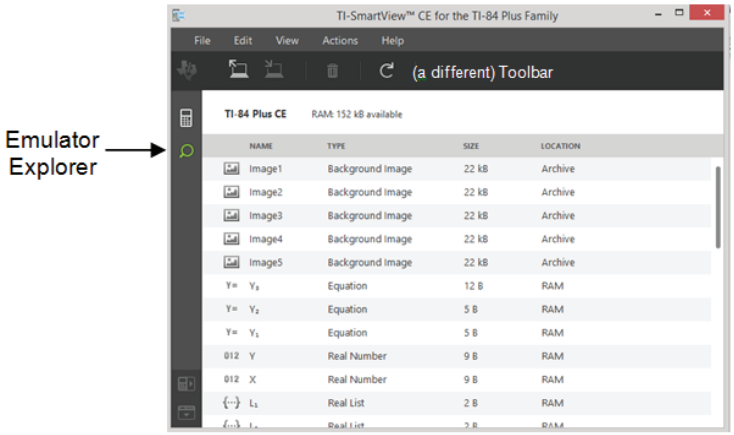
## Part One – Introduction to the software

- Launch the TI-SmartView™ CE software on your computer.
- Locate the Menu Bar, the Toolbar, and the Workspace Panel.

Calculator Emulator Workspace




Emulator Explorer Workspace



## Part Two – Using the Calculator Emulator Workspace

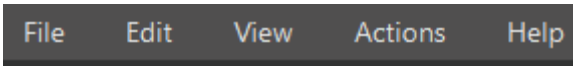
- Select the Calculator Emulator workspace from the Workspace Panel 

### A. Exploring the Calculator Emulator Toolbar

- Explore each item in the Calculator Emulator Toolbar. Click on the icon. What happens? What happens if you click it again? 
- Use the space below to record information about the toolbar items and their functions.

| | |
|---|---|
|  | |
|  | |
|  | |
|  | |
|  | |

### B. Exploring the Menu

- Explore each category in the Menu Bar and notice the options that are available. 
  (Most of the items in the Menu Bar can be completed by clicking icons in the toolbar.)
- What is something that *cannot* be completed by clicking an icon in the toolbar?

- From the Help option, choose “TI-SmartView CE Help” and browse the document. If possible, save the PDF file to your computer.

### C. Match the Screen

Use the Calculator Emulator workspace to graph:

$Y_1$=X-1
$Y_2$=X+3
$Y_3$=(X-1)(X+3)

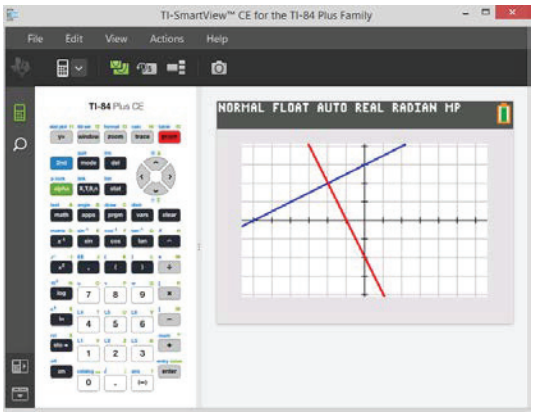
Use your calculator and software skills to make your TI-SmartView CE screen look like the one shown at the right.

## Part Three – Using the Calculator Emulator Workspace for Screen Captures

TI-SmartView™ CE Screen Capture allows the teacher to capture the current image displayed on the TI-SmartView™ emulator. When you capture a screen, the Screen Capture window is displayed. In this window, you can view, manipulate, and save screen images.

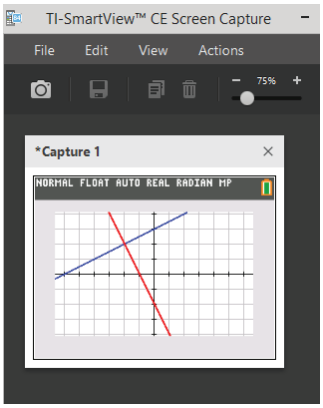
- Select the Calculator Emulator workspace from the Workspace Panel

- Create a screen image that you wish to capture. (home screen computations, data in lists, window settings, functions in Y=, a graph, …)




### Method 1: Using the Screen Capture tool

- Click on the toolbar (or choose *Capture Screen* from the Actions menu).
- Note: Ctrl T is a computer keyboard shortcut for a Screen Capture
- Explore the Menu and the Toolbar options in the TI-SmartView CE Screen Capture window.




### Method 2: Dragging and Dropping a Screen to Another Application

- You can drag and drop and paste any TI-SmartView™ CE screen into another application.

✓ Practice getting Screen Captures from the Calculator Emulator workspace.
✓ Try copy/pasting or dragging into another application such as Microsoft® Word.
✓ Read more about TI-SmartView™ CE Screen Captures in the TI-SmartView™ CE Help Guidebook.

**Notes:**

- Screenshots are saved in .png file format.
- Screenshots can be copied and pasted into a variety of other applications.
- Screenshots can be dragged and dropped into a variety of other applications.
- Screenshots can be resized using the slider in the screen capture window.
- A border is automatically added to each image when you capture it, but you can remove the border by clicking **View > Hide Screen Capture Borders**.
- The screen capture window can be used as a record of the steps in a lesson.

## Part Four – Using the Emulator Explorer Workspace

Emulator Explorer workspace allows you to manage emulator files, add content from your computer to your emulator, and send selected content to your computer.

- Select the Emulator Explorer workspace from the Workspace Panel.

### A. Exploring the Emulator Explorer Toolbar

- Explore each item in the Emulator Explorer Toolbar.
- Use the space below to record information about the toolbar items and their functions.

| | |
|---|---|
|  | |
|  | |
|  | |
|  | |

### B. Exploring the Menu

- Explore each category in the Menu Bar and notice the options that are available.

### C. Practicing with files in the Emulator Explorer

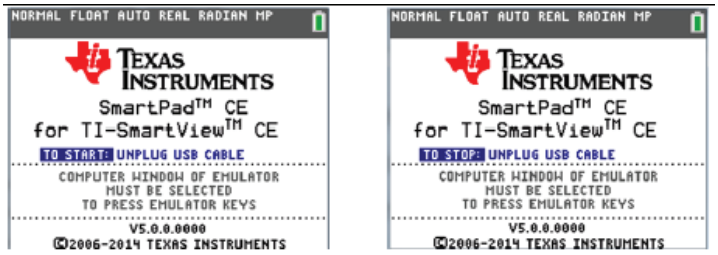
1. Copy (or drag) a file from the emulator to your computer.
2. Copy (or drag) a file from your computer to the emulator.
3. Drag an image (.jpg, .png, etc ) from your computer onto the Emulator Explorer. This will convert the image to a calculator/emulator background.

✓ Read more about using the TI-SmartView CE Emulator Explorer Workspace in the TI-SmartView CE Help Guidebook

## Part Five– Connecting a Calculator as a Remote Key Pad

The SmartPad™ CE App is available for the TI-84 Plus CE. To use the TI-84 Plus CE as a remote keypad for TI-SmartView™ CE:

1. Load the SmartPad™ CE App on your TI-84 Plus CE.
2. Connect your TI-84 Plus CE to your computer using a USB Computer cable which came with your calculator.
3. Launch TI-SmartView™ CE. Make sure the TI-SmartView™ CE window is in focus by clicking on the TI-SmartView™ CE window.
4. Run the SmartPad™ CE App on your TI-84 Plus CE. Press [apps] and select SmartPad™ CE from the Apps menu. Read the information on the splash screen.




5. Press keys on the calculator key pad.
6. Disconnect the USB cable from the calculator to stop the App and the remote key pad feature.
7. Reconnecting the USB cable and running the App again may be needed if the remote key pad connectivity is no longer responding.

**Notes:**

- SmartPad™ CE App running on the TI-84 Plus CE will remotely press emulator keys for the TI-84 Plus CE, TI-84 Plus C and TI-84 Plus emulators in TI-SmartView™ CE.
- TI-SmartView™ CE does not support any other version of SmartPad App running on the TI-84 Plus or TI-83 Plus.
- The TI-84 Plus CE running the SmartPad™ CE App will not display the calculations or graphs. The calculator becomes a remote USB key pad for the emulator only.

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# Memory Management in the TI-84 Plus Family

**TI PROFESSIONAL DEVELOPMENT**

## Activity Overview

*This activity explores memory management in the TI-84 Plus family of graphing calculators. This includes working with memory in RAM, archiving memory, and grouping files, lists, and variables for later retrieval.*

### Introduction

The TI-84 Plus CE is equipped with FLASH memory: special hardware that allows you to upgrade the operating system, install special software called apps, and utilize additional memory features. This extends the use life of the device and expands its functionality. This document explains two ways in which you can use the memory of the calculator for backing up your work.

**Note:** The TI-84 Plus CE graphing calculator is referenced throughout this activity, but the information applies to the entire TI-84 Plus graphing calculator family.

### Archiving and Grouping

Memory in the TI-84 Plus CE is divided into two sections:

1. RAM (**R**andom **A**ccess **M**emory) is the "working memory" for most things that are done on the calculator. Programs, lists, matrices, functions, and other data are kept in RAM. Each "thing" in RAM is called a variable. Each variable has three properties: a name, a type, and a value.
2. ARCHIVE memory is a separate, but connected, portion of memory used for APPS, GROUPS, and "safe" storage (archiving) of your RAM variables. Memory management is important because you might need to "free up" RAM to make room for other data or programs.

**Archiving** protects files from intentional or inadvertent resets. **Grouping** allows you to make copies of files, such as one student's Lists, so that another student can use the calculator for the same activity.

### Accessing Memory Features

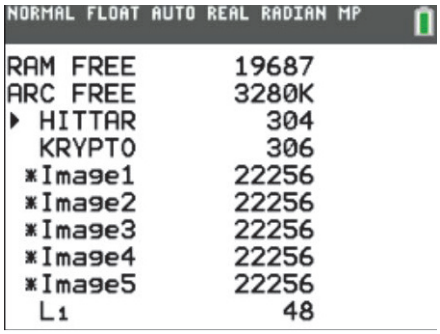
1. Press [2nd] [MEM] (on the [+] key) to access the MEMORY menu.


2. Select **2:Mem Mgmt/Del**. With this option, you can delete variables or move variables between the RAM and Archive areas of memory.
   - When a variable is in RAM, it is "usable". The variable is available for general use as a "normal" variable.

## Archiving

1. When the variable is in Archive memory, it is not available for use generally.
   - Apps, Pic, and Image variables are stored in Archive memory and can be used.
   - Why put a variable in archive? The main reason is to free up RAM for something else without deleting any variables.
   - Programs and lists are usually put into archive because these variables take up the most memory.

2. To archive, press [2nd] [MEM]. Then select **2:Mem Mgmt/Del**. Next, select **1:All** to see all of the variables. The variable list screen contains a lot of information:
   - The two numbers at the top, RAM FREE and ARC FREE, are the numbers of bytes available in each portion of memory, RAM and Archive.
   - On the left side of the screen is the "selection pointer" pointing to a particular variable. Move the selection pointer down or up with the arrow keys, [▲] and [▼].



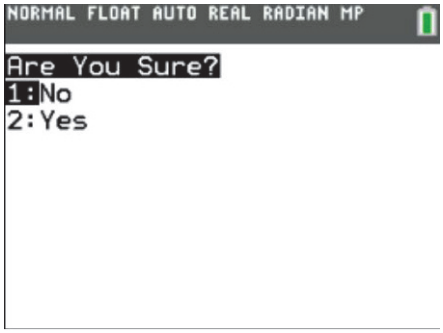

   - The second column (just to the left of the variable names) is the indicator that tells you whether a variable is in RAM or Archive**. A blank space indicates that it is in RAM, and an asterisk (*) indicates that it is in Archive**.
   - The number on the right of the screen is the size of the variable in bytes.

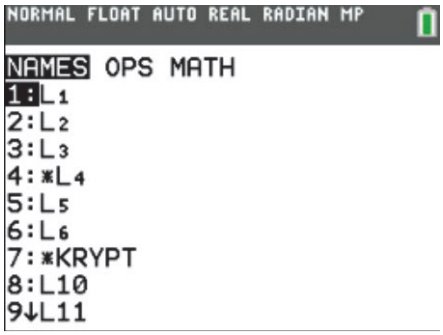
3. Press [ENTER] when the selection pointer is pointing to the variable.
   - [ENTER] switches the location of the variable.
   - "Archiving" is the act of moving a variable from RAM to Archive. "Unarchiving" is the opposite process.
   - As you move between RAM and ARCHIVE, notice the numbers at the top of the screen change to indicate new memory-free values. When you move a variable from RAM to Archive, the RAM FREE value increases and the ARC FREE value decreases by the size of the variable.
   - APPS and Pic & Image variables remain in archive and cannot be unarchived.

The Memory Management variable list screen is also used for deleting variables, although it is seldom necessary to delete variables on the TI-84 Plus CE. It is more convenient to move it into Archive memory.

4. To delete a variable, make sure the "selection pointer" is pointing to it, then press [DEL].

5. Some variables, programs, and anything in Archive memory provide you with one last chance to change your mind.
   - To finally delete the variable, select **2:Yes**. If you decide not to delete the variable, press [ENTER] or select **1:No**.






When a variable is in Archive, an asterisk appears to the left of its name in the List menu (2nd [STAT]) too.

- The List menu shown has two archived lists: L4 and KRYPT.
- Since L4 is in Archive memory, it is not available for regular use. If you try to make a Stat Plot using L4 while it is in Archive, you get an error message. This error message will appear whenever you try to use an archived variable.
- If a program is archived, it is not available for regular use. If you try to run the program while it is in Archive, you get an error message. This error message will appear whenever you try to use an archived program.
- If you need to use an archived variable, you must move it from Archive to RAM using the Memory Management tool.

### Grouping

The second useful memory management tool on the TI-84 Plus CE is the ability to "group" variables into a Group file. This is identical to the computer linking technique of grouping variables into a single file using TI Connect™ CE software (*.8xg files), but a computer is not needed here.

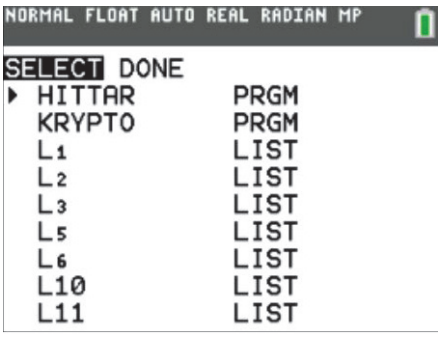
Grouping makes a file in the calculator containing copies of the variables that you want. Grouping does not "free up" memory. The Group file resides in Archive, so it does not use any RAM. This is a very handy tool for backing up your TI-84 Plus CE variables, especially programs and lists.

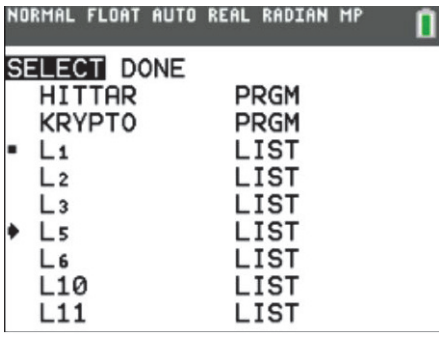
1. Select 2nd [MEM] 8:Group.


2. Select "Create New," enter any name up to eight characters long for the GROUP file, and press [ENTER].
   - The next screen works like the LINK-selection screen.

3. Selecting 2:All gives a list of all variables in the TI-84 Plus CE (that can be put into a Group file), unselected.


Just as in linking, use ▲ and ▼ to point to variables and press [ENTER] to select (or deselect) them for copying into the Group file.



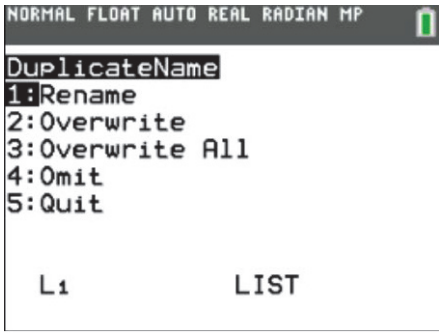

- The two lists, L1 and L5, have been “selected” for this Group file (note the square mark).
- You might choose mixed data types as well. For instance, choose some lists, some programs, and some matrices.
- Pic & Image variables cannot be grouped.
- When you have selected all your variables, press ▶ to go to the “DONE” menu, and press [ENTER] to finish making the Group file.
- The Home Screen displays the message: “Copying Variables to Group: yourname”, and then displays “Done” on the right side of the screen.
- The key word here is “copying”— your variables are undisturbed in RAM. The Group file contains copies of the selected variables, just as linking transmits copies of your variables to another TI-84 Plus CE.

**Note:** You cannot have a group with just one object. Each group must contain at least two objects. The Group files reside in Archive, so a “normal” Reset, “[2nd] [MEM], 7:Reset, 1:AllRam, 2:Reset”, will not disturb any Group files. These Group files can be linked (sent) to other TI-84 Plus CE units, and can be stored on a computer using TI Connect™ CE software.

## Ungrouping

"Ungrouping" is the act of putting copies of the variables in a Group file back into RAM. The Group file remains intact while the variables are copied back into RAM.

1. Select 2nd [MEM] 8:Group.
2. Press ▶ to UNGROUP, and select your Group file from the listing using ▼ and ▲ (notice the asterisks – all Group files reside in Archive).
   - Press ENTER. If any of the variables in the Group file are already in RAM, then you get a "DuplicateName" menu of choices.
   - Just as in Linking, choose 2:Overwrite to overwrite the variable with the one from the Group file.


**Notes:**

- You cannot put an Archived variable into a Group file. Unarchive it first, then make the Group file.
- Once a Group file is established, it cannot be modified, only UNGROUPED or DELETED. Thus you cannot add variables to a group file afterward.
- When linking to a computer, you cannot make a group file on the computer containing a Group file from the TI-84 Plus CE.

**Tip:** Make a Group file of all your programs to prevent loss from inadvertent resets. When you add programs to the TI-84 Plus CE that you want to keep, delete the programs Group and then make it again.

- It is convenient to Group everything on your handheld before resetting RAM. You can quickly restore everything after resetting the RAM by ungrouping the file. You can then delete that group.

## Deleting A Group

1. Selecting 2nd [MEM], **2:Mem Mgmt/Del**, and **C:Groups** gives the list of Group files.
2. Press ▼ next to one of them to delete it. Press the appropriate choice at the "Are You Sure?" menu.
   - Use 2nd [MEM], **8:Group** for Grouping and Ungrouping.
   - Use 2nd [MEM], **2:Mem Mgmt/Del**, and **C:Groups** for viewing the sizes of and deleting Group files.

**Tip:** When the archive gets full, consider putting large Group files on a computer, and then deleting them from the TI-84 Plus CE.

## Summary of Memory Management

- Two sections of memory: RAM and Archive.
- Archiving/Unarchiving moves variables.
- Grouping/Ungrouping copies variables.
- Archived variables are unavailable for use, except for Pic & Image.
- Grouped variables are still available for use.
- You cannot put an archived variable into a group file.
- Archived variables and group files can be transferred to other calculators or a computer.
- Ungrouping leaves the group file intact.
- Rather than deleting to free up RAM, consider moving to Archive first.
- Normal Reset (2nd [MEM] **> 7:Reset > 1:AllRam > 2:Reset**) leaves archived variables and group files intact.

## Memory Management Keystroke Summary

### Archive/Unarchive

- 2nd [MEM], 2:Mem Mgmt/Del.
- **1:All** (or choose your variable sub-type).
- ▼▲ to point to a variable.
- ENTER to move a variable (note the * toggle).

### Group

- 2nd [MEM], 8:Group, 1:CreateNew.
- Enter a group name.
- ▼▲ ENTER to select multiple variables (note the squares).
- ▶ to DONE.
- ENTER to execute the grouping.

### Ungroup

- 2nd [MEM], 8:Group, ▶ to UNGROUP.
- ▼▲ to point to the desired group file.
- ENTER to execute the ungrouping.

### Deleting Variables

- 2nd [MEM], 2:Mem Mgmt/Del.
- **1:All** (or choose your variable sub-type).
- ▼▲ to point to a variable.
- DEL, possibly “Are You Sure?” will appear.

## One Final Note

On the 2nd [MEM] menu, there are two menu items, **5:Archive** and **6:UnArchive**. These are used in programs so that the program can manipulate specific variables’ locations. For example, a program might contain the statement ‘Archive L1, L2, L3, L4, L5, L6’ which will move these six lists from RAM to Archive. You do not need to use these two commands unless you are programming.

# Let's Talk, Calculator–to–Calculator

**TI PROFESSIONAL DEVELOPMENT**

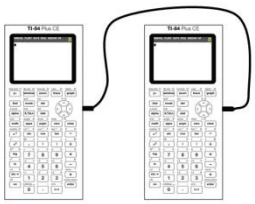
## Activity Overview

*In this activity, you will practice sending files from one TI-84 Plus graphing calculator to another. Below is a description of how to transfer a file between calculators in the TI-84 Plus family.*

## Transferring Between Calculators

**Step 1:**

Connect a unit-to-unit link cable between the two calculators.



If using the TI-84 Plus CE, the USB port is on the right side of the calculator. If using other TI-84 Plus calculators, the USB port is located at the top right edge.

- Firmly insert either end of the USB unit-to-unit cable into the USB port.
- Insert the other end of the cable into the other calculator's USB port.

-or-

If using the TI-84 Plus C Silver Edition, the TI-84 Plus Silver Edition, or the TI-84 Plus, the I/O port is located at the top left edge of the graphing calculator.

- Firmly insert either end of the I/O unit-to-unit cable into the port.
- Insert the other end of the cable into the other calculator's I/O port.

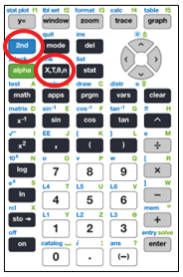
**Step 2:**

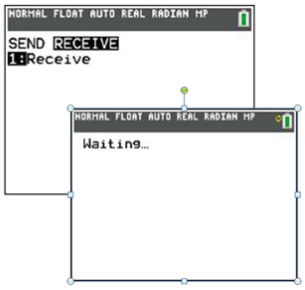
On the **Receiving** calculator:

- Press [2nd] [Link].
- Right arrow to RECEIVE.
- Press [ENTER].

The screen will display a "Waiting…" message

Receiving Calculator



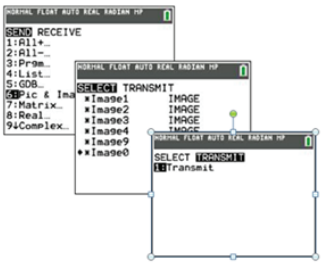



**Step 3:**

On the **Sending** calculator:

- Press [2nd] [Link].
- Scroll down to the file type you want to transfer. Press [ENTER].
- Scroll to the files you want, and press [ENTER] to mark each of them.
- Right Arrow to TRANSMIT, and press [ENTER].

Sending Calculator




The square mark indicating selected files appears directly under the scroll cursor. Move the cursor up or down to see it more clearly. The receiving calculator will get the files or display a "Duplicate Name" message. Follow the on-screen prompts.

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# TI-84 Plus CE Experience Survey

## TI PROFESSIONAL DEVELOPMENT

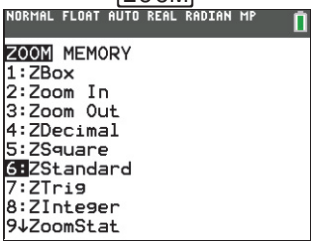
### Activity Overview

*Review the twelve screens included in this survey. Score yourself using the scale provided depending upon your experience, and note items you have questions about. Total your score at the bottom.*

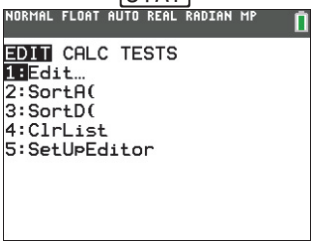
1 for beginner
2 for advanced beginner
3 for average
4 for above average
5 for expert

[WINDOW]

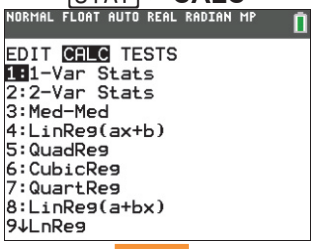

[ZOOM]



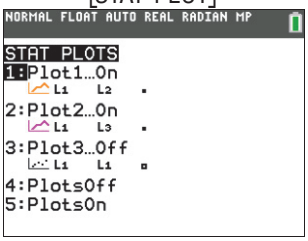

[STAT]



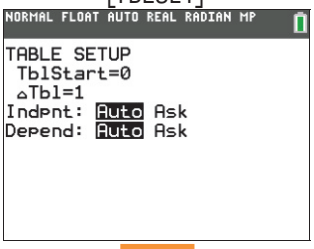

[STAT] > **CALC**



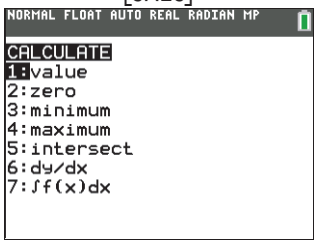

[STAT PLOT]



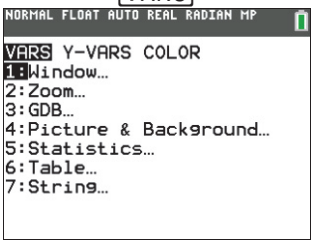

[TBLSET]



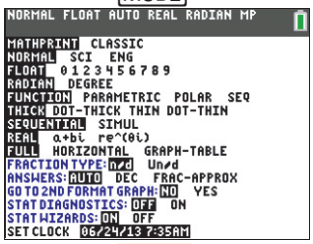

[CALC]



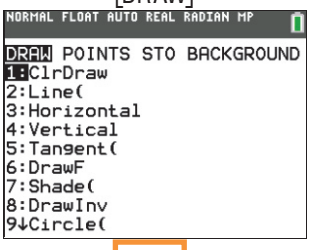

[VARS]



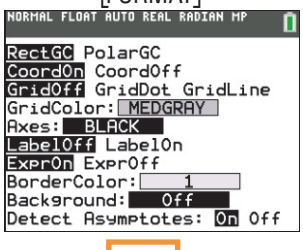

[MODE]



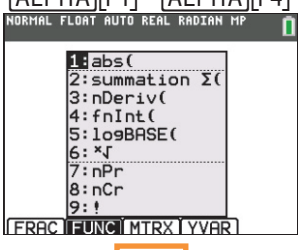

[DRAW]




[FORMAT]




[ALPHA][F1] - [ALPHA][F4]




Total Score

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# TI Technology Exam Acceptance

**TI PROFESSIONAL DEVELOPMENT**

## TI-Nspire™ Technology

| Approved for Tests | TI-Nspire™ CX<br>TI-Nspire™ w/Touchpad<br>TI-Nspire™ w/Clickpad | TI-Nspire™ CX CAS<br>TI-Nspire™ CAS w/Touchpad<br>TI-Nspire™ CAS w/Clickpad |
|---|---|---|
| SAT* | ● | ● |
| AP* | ● | ● |
| PSAT/NMSQT* | ● | ● |
| ACT* | ● | |
| International Baccalaureate | ● | |
| Praxis™ | ● | ● |
| Texas STAAR® Grade 8 | ● | |
| Texas STAAR® Algebra | ● | |

## Graphing Technology

| Approved for Tests | TI-84 Plus CE<br>TI-84 Plus C Silver Edition<br>TI-84 Plus Silver Edition<br>TI-84 Plus, TI-83 Plus | TI-89 Titanium |
|---|---|---|
| SAT* | ● | ● |
| AP* | ● | ● |
| PSAT/NMSQT* | ● | ● |
| ACT* | ● | |
| International Baccalaureate | ● | |
| Praxis™ | ● | ● |
| Texas STAAR® Grade 8 | ● | |
| Texas STAAR® Algebra | ● | |

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