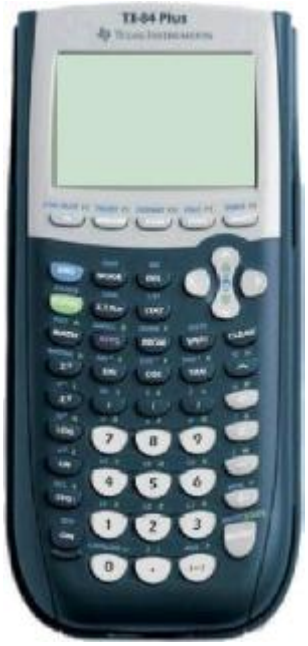
Introduction to the TI-84+ Graphing Calculator

This tutorial is intended to provide a general overview of some of the capabilities of the TI-84+ graphing calculator. Examples of the wide range of operations available on this powerful tool are included in the following pages.

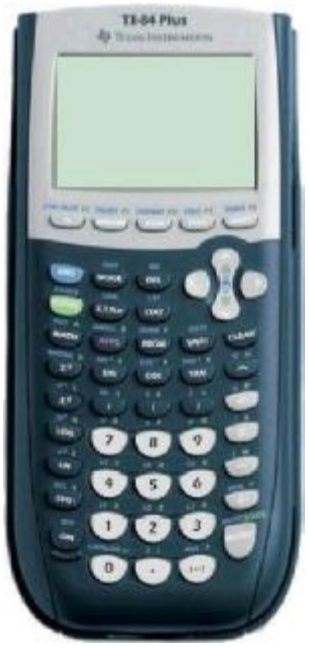


For more detail and resources, refer to:

The TI84Plus Guidebook, available in PDF format at http://education.ti.com/
TI-84 Plus Graphing Calculator for Dummies by C. C. Edwards

or search **Google** using keywords such as TI-84.

General Layout of the Keypad

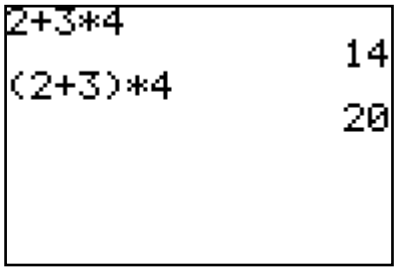


The TI-84+ graphing calculator operates on a Zilog Z80 CPU, running at 15 MHz. It retains the same functionality as its predecessor, the TI-83+, but offers more memory, and several updated features. Keypress sequences that work on one usually work on the other.

The keys on the TI-84+ are colour-coded by function.
- The white keys include the number keys, decimal point, and negative sign. When entering negative values, use the (-) white key not the − grey key.
- The white keys include the number keys and the minus key (-).
- The grey keys on the right side are the math operations and the ENTER key.
- The grey keys across the top are used primarily for graphing.
- The grey arrow keys control the cursor.
- The black keys include commonly-used functions, as well as leading to other menus.
- The primary function of each key is printed on the key.
- The secondary function of each key is printed in blue and is activated by pressing the blue 2ND key first. For example, to find the square root of a number, press 2ND x^2 for $\sqrt{\ }$.
- The alpha function of each key is printed in green and is activated by pressing the green ALPHA key first. For example, to enter an A, press ALPHA then MATH.

Arithmetic Operations

The TI-84+ is programmed to follow standard order of operations.
- Type 2 + 3 * 4, and press ENTER.
- Type (2 + 3) * 4), and press ENTER.



Note the difference in the answer.

Working With Fractions

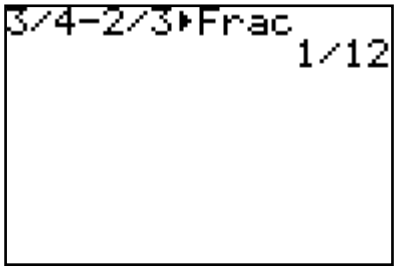
To display a decimal as a fraction:
- Key in a decimal.
- Press MATH, and select **1: ►Frac**. Press ENTER.

The decimal will be displayed as a fraction.

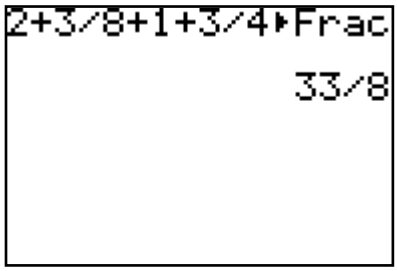
To enter fractions in calculations:
- Use the division key ÷ to create fractions as you key them in.
- If you want the result displayed as a fraction, Press MATH, and select **1: ►Frac**.
- Press ENTER.

For example, to calculate $\frac{3}{4}-\frac{2}{3}$:
- Press **3** ÷ **4** − **2** ÷ **3**.
- Then, press MATH, select **1: ►Frac**, and press ENTER.

The result will be displayed as a fraction.

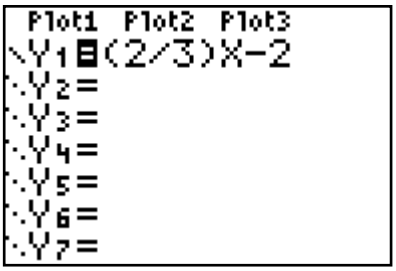


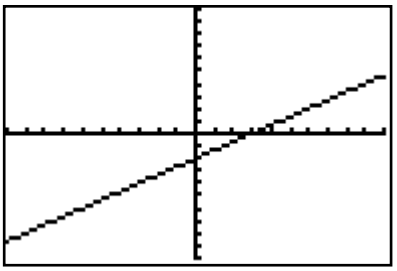
To calculate with mixed numbers:
● Use the + and ÷ keys to enter mixed numbers.
● If you want the result displayed as a fraction, press MATH, select **1: ►Frac**, and press ENTER.



For example, to calculate $2\frac{3}{8}+1\frac{3}{4}$:
● Press **2** + **3** ÷ **8** + **1** + **3** ÷ **4**.
● Then, press MATH, select **1: ►Frac**, and press ENTER.
The result will be displayed as a fraction.

Graphing Relations and Functions
You can enter functions using the Y= editor.
● Press Y=. Enter the equation.
● Press GRAPH.



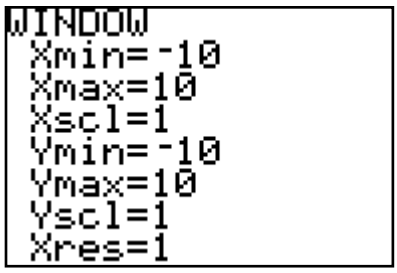


Tip: If you want to display the graph in a standard window, 10 units in each direction, press ZOOM, then select **6:ZStandard**.

For example, enter $y=\frac{2}{3}x-4$ by pressing Y= (**2** ÷ **3**) X,T,θ,*n* – **4**.

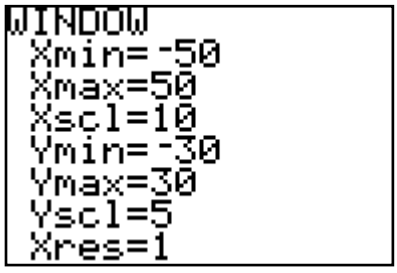
Press Y= to return to the equation. Use the cursor keys to move to the space to the left of Y_1. Press ENTER repeatedly. You can change the format of the graph, changing the style to a dotted line or a heavy line, or adding shading above or below. Experiment with these options.

Setting Window Variables
The WINDOW key defines the appearance of the graph. The standard (default) window settings are 10 units in any direction, with ticks at every unit.

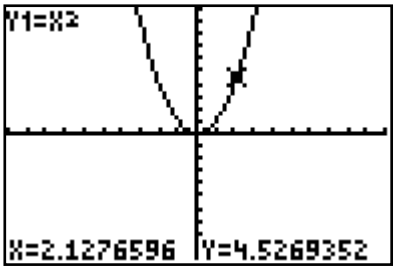


To change the window settings:
● Press WINDOW. Enter the desired window settings.

In the example shown,
● the minimum *x*-value is –50
● the maximum *x*-value is 50
● the scale of the *x*-axis is 10
● the minimum *y*-value is –30
● the maximum *y*-value is 30
● the scale of the *y*-axis is 5
● the resolution is 1, so equations are graphed at each horizontal pixel



Tracing a Graph



- Enter a function such as $y = x^2$ using the Y= editor.
- Press TRACE.
- Press ◄ and ► to move along the graph.

The *x*- and *y*-values are displayed at the bottom of the screen.

Tip: If you or a previous user has entered data for a statistical plot, you may need to turn off all STAT PLOTS before you can trace a function:

- Press 2nd Y= for [STAT PLOT]. Select **4:PlotsOff**.
- Press ENTER.

Setting the Format

You can change the appearance of the viewing window.

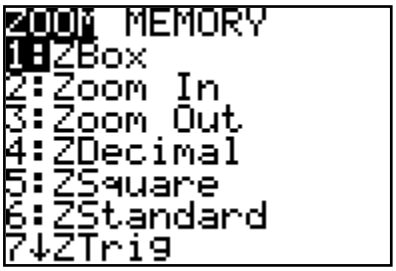
- Press 2nd ZOOM for [FORMAT] to view the choices available.

The **Default Settings** have all the features on the left active.

To turn on the grid:

- Select [FORMAT] by pressing 2nd ZOOM. Cursor down and right to **GridOn**. Press ENTER.
- Press 2nd MODE for **[**QUIT**]**.

Using Zoom

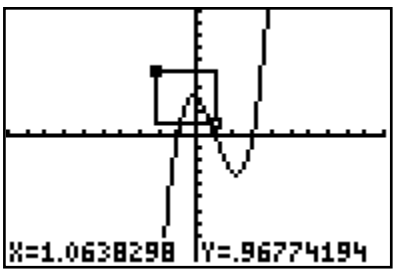


The ZOOM key is used to change the area of the graph that is displayed in the graphing window.

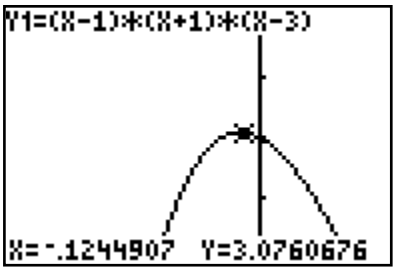
You can "zoom in" on one small area of a graph.

- Enter a function such as $y = (x – 3)(x – 1)(x + 1)$.
- Graph the function in a standard window.

Zoom in on the local maximum.



- Press ZOOM. Select **1:Zbox**. The graph screen will be displayed, and the cursor will be flashing.
- If you can't see the cursor, use the ◄, ►, ▲, and ▼ keys to move the cursor until you see it.
- Move the cursor to approximately (–2, 5).
- Press ENTER to mark that point as a starting point.
- Press the ◄, ►, ▲, and ▼ keys to move the cursor to approximately (1, 1).
- Press ENTER. The area will now appear larger.



You can press TRACE to determine the coordinates of the local maximum.

ZOOM Options

To zoom in on an area without identifying a boxed-in area:

● Press ZOOM. Select **2:Zoom In**.

To zoom out of an area:

● Press ZOOM. Select **3:Zoom Out**.

To display the viewing area where the origin appears in the centre and the *x*- and *y*-axes intervals are equally spaced:

● Press ZOOM. Select **4:ZDecimal**.

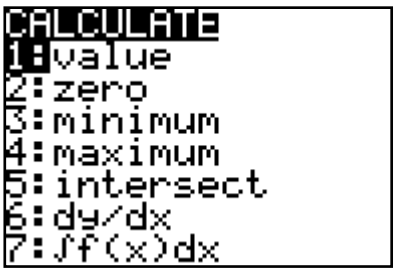
To reset the axes range on your calculator:

● Press ZOOM. Select **6:ZStandard**.

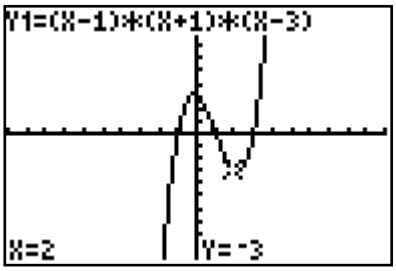
Working With Functions

You can determine various attributes of a function using the **CALC** menu.

● Enter a function such as $y = (x - 3)(x - 1)(x + 1)$.
● Graph the function in a standard window.
● Press 2nd , then TRACE to access the **CALC** menu.
● Select **1:value**.
● Type a value such as $x = 2$, and press ENTER.



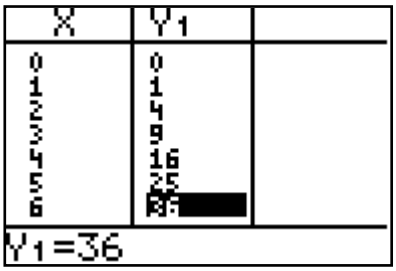
The value of *y* at $x = 2$ will be displayed.



To find the zero of a function, select **2:zero**.

● Move the cursor to the left of the zero, and press ENTER.
● Move the cursor to the right of the zero, and press ENTER.
● Move the cursor close to the zero, and press ENTER.

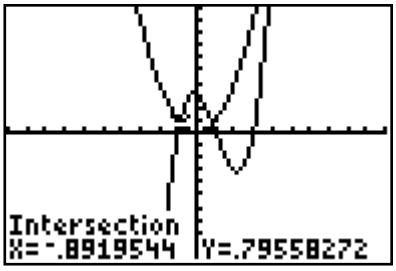
The zero of the function will be displayed. In a similar manner, you can find maxima and minima. Experiment with these.



You can see a table of values for a function by pressing 2nd , then GRAPH to access the **TABLE**. Scroll up or down to see other values. If you press 2nd , then WINDOW to access **TBLSET**, you can change the starting value and increment for the table.

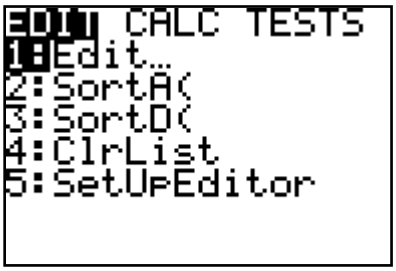
If you enter a second function, you can determine the intersection of the two functions.

● Enter a function such as $y = x^2$ as Y_2.
● Graph the function in a standard window.
● Press 2nd , then TRACE to access the **CALC** menu.
● Select **5:intersect**.
● Press ENTER to select the first function.
● Press ENTER to select the second function.
● Move the cursor close to the intersection, and press ENTER.



Entering Data Into Lists

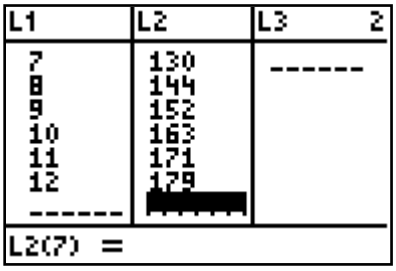
Lists are primarily used for statistical data.



- Press STAT. The cursor will highlight the **EDIT** menu.
- Press **1** or ENTER to select **1:Edit…**.

This allows you to enter new data, or edit existing data, in lists **L1** to **L6**.

For example, press STAT, select **1:Edit…**, and enter data as shown in lists $\mathbf{L_1}$ and $\mathbf{L_2}$. The data show shoe size and height for a sample of six students.



- Use the cursor keys to move around the editor screen.
- Complete each data entry by pressing ENTER.
- Press 2nd MODE for **QUIT** to exit the list editor when the data are entered.

You may need to clear a list before you enter data into it. For example, to clear list $\mathbf{L_1}$:

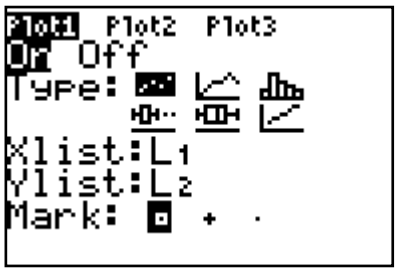
- Press STAT and select **4:ClrList**.
- Press 2nd **1** for $\mathbf{L_1}$, and press ENTER.

To clear all lists:

- Press 2nd + for [MEM] to display the **MEMORY** menu.
- Select **4:ClrAllLists** and press ENTER.

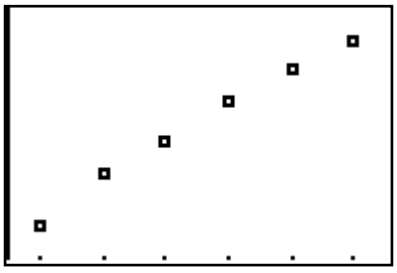
Creating a Scatter Plot

To create a scatter plot:



- Enter the data for shoe size and height in lists $\mathbf{L_1}$ and $\mathbf{L_2}$.
- Press 2nd Y= for **STAT PLOT**.
- Press **1** or ENTER to select **1:Plot1…**.
- Press ENTER to select **On**.
- Cursor down, then press ENTER to select the top left graphing option, which is a scatter plot.
- Cursor down and press 2nd **1** for $\mathbf{L_1}$.
- Cursor down and press 2nd **2** for $\mathbf{L_2}$.
- Cursor down and select a mark style. Press ENTER.
- Press 2nd MODE for [QUIT] to exit the **STAT PLOTS** editor when the data are entered.

To display the scatter plot:

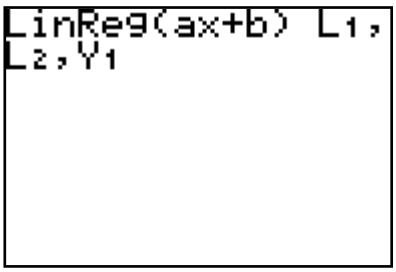


- Press Y= and use the CLEAR key to remove any graphed equations.
- Press 2nd MODE for **QUIT** to exit the **Y=** editor.
- Press ZOOM and select **9:ZoomStat** to display the scatter plot.

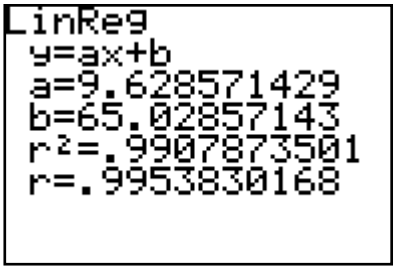
This will adjust the window settings such that all of the points are displayed.

Line of Best Fit

You can add the line of best fit to a scatter plot by using the **LinReg** function:



- With the scatter plot displayed, press STAT.
- Cursor to display the **CALC** menu.
- Select **4:LinReg(ax+b)**.
- Press 2nd **1** for $\mathbf{L_1}$, followed by , .
- Press 2nd **2** for $\mathbf{L_2}$, followed by , .
- Press VARS, and cursor over to display the **Y-VARS** menu.
- Select **1:FUNCTION**, and then select **1:$\mathbf{Y_1}$**.

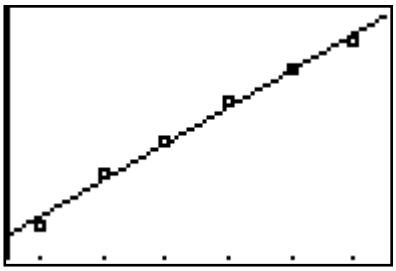


This will place the results of the linear regression as function Y_1.

- Press ENTER to get the LinReg screen.

The regression equation is approximately $y = 9.63x + 65.03$.

- Press GRAPH.



The regression line will be displayed over the statistical plot.

You can also perform various non-linear regression operations, such as quadratic regression, exponential regression or sinusoidal regression.

The linear regression equation is stored in the **Y=** editor. If you press Y=, you will see the equation determined by the calculator.

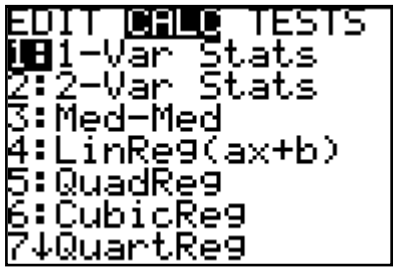
Note: If the diagnostic mode is turned on, you will see values for **r** and $\mathbf{r^2}$ displayed on the LinReg screen. To turn the diagnostic mode off:

- Press 2nd **0** for **CATALOG**.
- Scroll down to **DiagnosticOff**. Press ENTER to select this option.
- Press ENTER again to turn off the diagnostic mode.

You can turn diagnostic mode on in a similar manner.

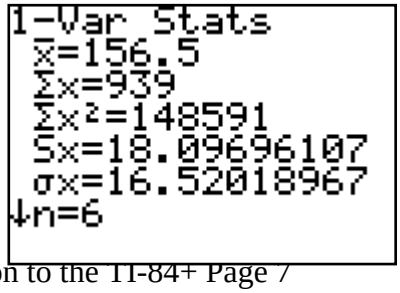
1- Variable Statistics

You can display statistics for a data set. Consider the height data entered in list $\mathbf{L_2}$.



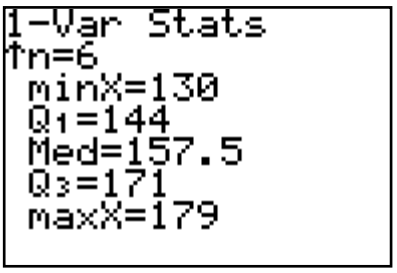
- Press **STAT** and cursor right to select the **CALC** menu.
- Press **1** or **ENTER** to select **1-Var-Stats.**
- Press 2nd **2** for $\mathbf{L_2}$, and press **ENTER**.

A set of statistics will be displayed, as shown.



The first line, $\bar{x} = 156.5$, is the mean.
The final line on the first screen, n = 6, is the number of data.

You can cursor down for more statistics.



minX = 130 is the minimum value in the data set.

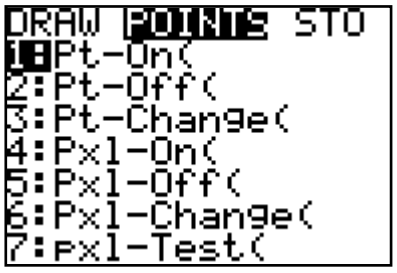
Med = 157.5 is the median of the data set.

maxX = 179 is the maximum value in the data set.

Plotting Points

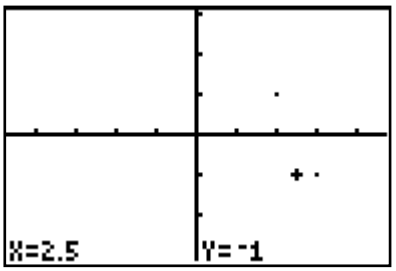
You can draw points on the TI84+ using the **DRAW** menu.

- Press the **ZOOM** key, and select **4:ZDecimal**.
- Press 2ND **PRGM** to access the **DRAW** menu.
- Use the right cursor to select the **POINTS** menu.
- Press **ENTER**.



This turns on the points plot routine.

- Move the cursor to the point (2, 1).
- Press **ENTER**. Move the cursor to (3, –1).



A point has been plotted at (2, 1).

- Press **ENTER**.

Another point has been plotted at (3, –1).

Programming the TI-84+

You can program the calculator to accept data as input, and then, output any desired calculation. This is useful for common calculations, such as the Pythagorean theorem, the Sine Law, or the Cosine Law. As an example, write a program to accept the lengths of the sides of a right triangle, and calculate the length of the hypotenuse. The lengths of the sides are 7 units and 24 units.

1. Input the data.

- Press **PRGM**. Select **NEW**, then **Create New**.
- Type in a name, such as PYTHHYP, and press **ENTER**.
- Press **PRGM**. Select **I/O**, and then, **2:Prompt**.
- Press **ALPHA**, then **MATH** to type a variable A. Press **ENTER**.
- Press **PRGM**. Select **I/O**, and then, **2:Prompt**.
- Press **ALPHA**, then **APPS** to type a variable B. Press **ENTER**.

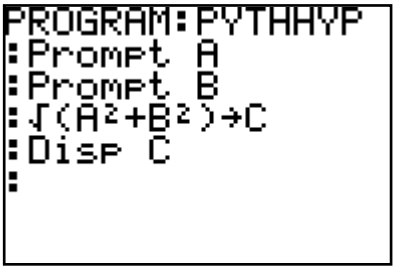
2. Perform the calculation.

- Press **2nd** and x^2 to start a square root. Press **ALPHA**, then **MATH**.
- Type **^ 2 +**. Press **ALPHA**, then **APPS.**
- Type **^ 2)**. Press **STO** **ALPHA** **PRGM**. Press **ENTER**.

3. Display the result.

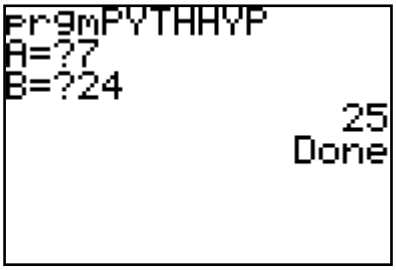
- Press **PRGM**. Select **I/O**, and then, **3: Disp**.
- Press **ALPHA** **PRGM**. Press **ENTER**.

Your screen will appear as shown.



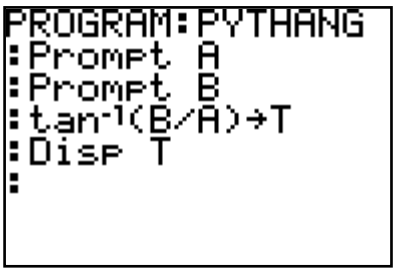
● Press 2ND **MODE** for **QUIT** to store the program.

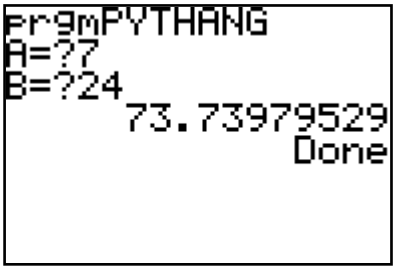
4. Run the program.
● Press **PRGM**. Select PYTHHYP. Press **ENTER**.
● You are prompted for the value of A. Type 7. Press **ENTER**.
● You are prompted for the value of B. Type 24. Press **ENTER**.



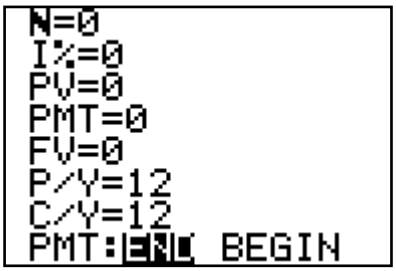
The length of the hypotenuse is displayed as 25.

5. Program the calculator to calculate an angle measurement. A possible program screen is shown. When you are finished, run the program. A possible output is shown.



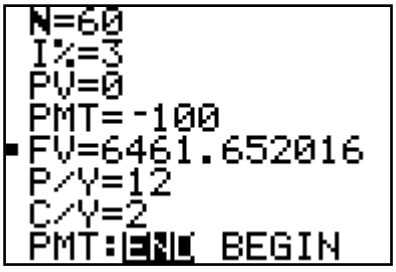


Using the TVM Solver (Time Value of Money)
The TVM Solver accepts data related to finance problems, and will calculate the unknown. For example, suppose that you make a payment of $100 at the end of each month into an account that pays 3%/a compounded semi-annually. How much will you have after 5 years?



● Press **APPS**.
● Select **Finance**, then **TVM Solver**.
● Enter 60 for N (number of payments), and 3 for I% (interest rate).
● Enter 0 for PV (present value), and -100 for PMT (payment).
● Leave FV (future value) for now.
Tip: Money paid to the bank is considered as negative. Money that you get from the bank is considered as positive.

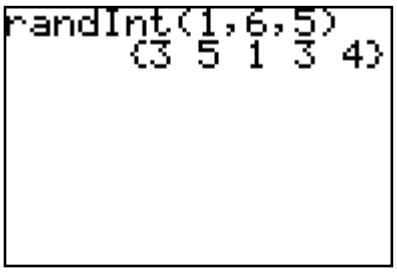
● Enter 12 for P/Y (payments per year) and 2 for C/Y (compounds per year).
● Cursor back up to FV.
● Press **ALPHA** then **ENTER** to access **SOLVE.**



The future value will be displayed. Note that this number is positive.

Generating Random Integers

The TI-84+ is capable of generating different kinds of random numbers. For example, you can generate random integers to simulate rolling of dice, selection of cards from a deck, or other scenarios. Suppose you want to simulate five random rolls of a die.

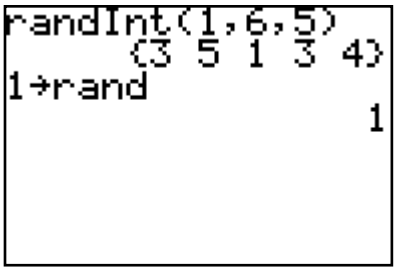


- Press MATH key, and cursor right to the **PRB** menu.
- Select **5:randInt(**.
- Type 1,6,5) ENTER.

Five random integers between 1 and 6 will be displayed.

You can also generate random real numbers between 0 and 1 using **1:rand**, random numbers from a normal distribution using **6:randNorm(**, or random numbers from a binomial distribution using **7:randBin(**.

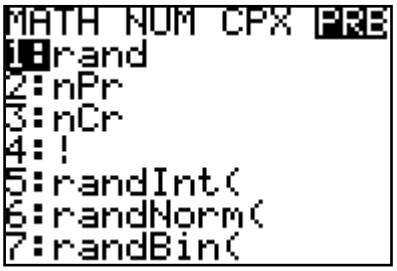
A Note About Seeds: Whenever you use any of the random number functions, you will generate the same series of random integers. The start of the series is controlled by the value of the variable **rand** which is stored internally in the TI84+, and is set to zero by default. If you change the default value to something else, you can generate a different series. For example, you can change the default to 1 using the keystrokes 1 STO MATH ⇐ 1.



To ensure random numbers in a classroom, you might ask students to use a seed which is the sum of their birthday plus street number. For example, a student born on April 30 and living at 190 Main St. would use 30 + 190 = 220 as a seed.

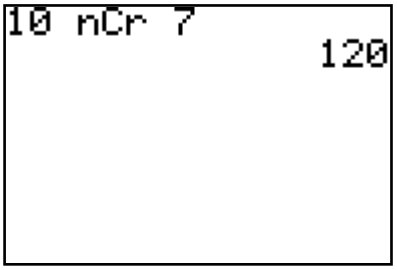
Combinatorics

TheTI-84+ will calculate permutations and combinations. Suppose you want to evaluate the number of subsets of 10 objects taken 7 at a time, or 10 choose 7.



- Type 10.
- Press the MATH key, and cursor to **PRB**.
- Select **3:nCr**.
- Type 7 and press ENTER.

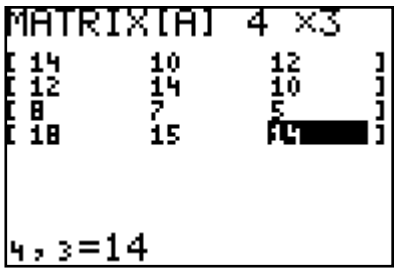
The answer 120 will be displayed.



You can calculate permutations in a similar manner, using option **2:nPr**.

Matrix Operations
You can store and perform operations on matrices using the TI-84+.

Consider the matrix shown: $A = \begin{bmatrix} 5 & 1 & -2 \\ 4 & -2 & 0 \end{bmatrix}$



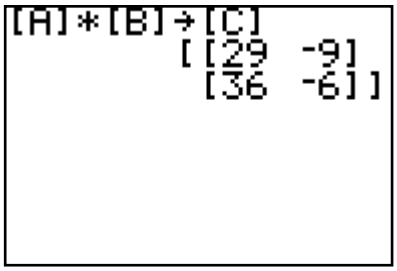
- Press 2ND x^{-1} to access the **MATRIX** menu.
- Cursor to **EDIT** and then select 1, which is matrix [A].

The default dimensions are 1 × 1. Change these to 2 × 3. Notice that the matrix enlarges to the desired dimensions.

- Cursor to the first element.
- Type 5 and press ENTER.

Continue to fill in the elements of the matrix.
- Press 2ND MODE to **QUIT**.

In a similar manner, store matrix [B]: $B = \begin{bmatrix} 7 & 0 \\ -4 & 3 \\ 1 & -6 \end{bmatrix}$



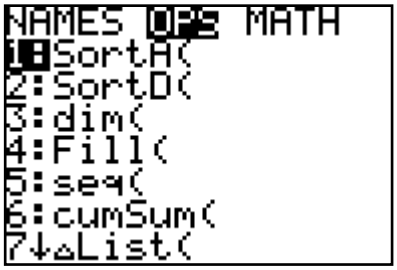
You can multiply these matrices, and store the result in matrix [C].

- Press 2nd x^{-1} 1 × 2nd x^{-1} 2 STO 2nd x^{-1} 3.

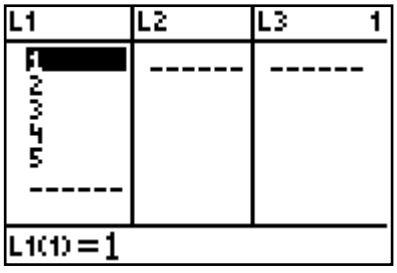
These keystrokes will multiply [A] by [B] and store the result in [C]. The elements of [C] will be displayed.

You can perform a host of other operations, including addition, subtraction, finding determinants, or changing to row-reduced echelon form.

List Operations
You can use the List Operations as a "poor man's spreadsheet". For example, suppose you want to sort a list of numbers such as 2, 1, 5, 4, 3 into ascending order.

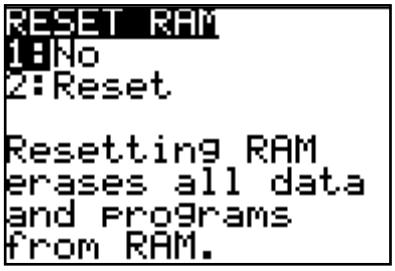


- Enter the numbers into list $\mathbf{L_1}$.
- Press 2nd STAT and cursor to **OPS.**
- Select **1:SortA(**.
- Press 2nd 1 for $\mathbf{L_1}$ and type).
- Press ENTER.
- Press STAT and select **1:Edit**.



The ordered list will be displayed. You can sort a list into descending order using the **SortD(** function.

Resetting the Random Access Memory (RAM) (Use With EXTREME Caution!)
To erase a previous user's settings,, including clearing lists, variables, stored programs, and other data, reset the memory. This will set the calculator back to the default settings.



This is a powerful command. All user created programs will be erased from the calculator.

- Press 2ND + for **MEM**.
- Select **7:Reset**.
- Select **1:All RAM.**
- Select **2:Reset**.

You will see a message "**RAM cleared**". Press **ENTER** and continue with your activity.

Using the CBR™ (Calculator Based Ranger)
You can use the CBR sonic sensor to gather motion and time data in real time, and then, analyse the data graphically and statistically.

To access the CBR™ through the TI-84+:
- Connect the CBR™ to the TI-84+ with the calculator-to-CBR cable.
- Make sure both ends of the cable are firmly in place.
- Press APPS.
- Select **CBL/CBR**.
- When the CBL/CBR™ screen is presented, press ENTER.
- To access the programs available, select **3:Ranger**.
- When the **Ranger** screen is presented press ENTER.

To record data from the CBR™:
- From the MAIN MENU screen, select **1:SETUP/SAMPLE**.

All settings, except TIME (S), can be changed by using the cursor keys to position the ►beside the current option and pressing ENTER to cycle through the choices. To change the TIME (S) setting. cursor down to TIME (S), enter the desired value and press ENTER.

Aim the sensor at the moving object.

- Move the cursor up to START NOW at the top of the screen, and press ENTER twice.

You can watch the distance vs time graph being generated in real time.

- Press ENTER. and select **5:QUIT**.

The data will be stored in lists 1 to 4 as shown.