



# **Graphing Calculator Apps Guide for the TI-84 Plus CE-T *Python Edition***

To obtain the latest version of the documentation, go to [education.ti.com/eguide](https://education.ti.com/eguide).

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Choose **Applications** as your technology, and then select:

**Guidebook for TI-83 Plus/TI-84 Plus.**

**Note:** The expanded guidebooks contain comprehensive information, but some content may refer to older versions of the App.

The TI-83 Plus/TI-84 Plus App guidebooks contain:

- Getting started activities
- Comprehensive feature information
- Step-by-step functional details

**Note:** Some functionality may differ on the CE graphing calculators.

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# Using Cabri™ Jr. Geometry App

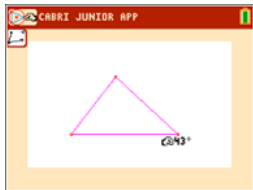
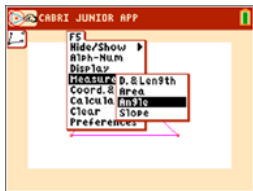
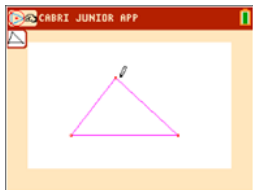
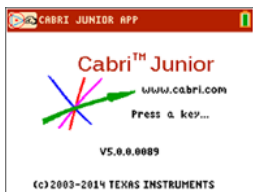
Use the Cabri™ Jr. App to construct, analyze, and transform mathematical models and geometric diagrams on your TI graphing calculator. You can:

- Perform analytic, transformational, and Euclidean geometric functions
- Build geometric constructions interactively with points, a set of points for locus, lines, polygons, circles, and other basic geometric objects
- Alter geometric objects on the fly to see patterns, make conjectures, and draw conclusions

## Example Activity – Draw and Measure a Triangle

Use this activity to learn the basics the Cabri™ Jr. App.

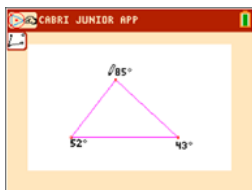
1. Press the **[apps]** key and select Cabri™ Jr.
2. Press any key.
3. Create a triangle.
  - a) Press **[window]** to open the F2 menu.
  - b) Select **Triangle**.
  - c) Move the pencil using the **[left]** **[right]** **[up]** **[down]** keys to a location for the first vertex. Press **[enter]**.
  - d) Move the pencil using the **[left]** **[right]** **[up]** **[down]** keys to a location for the 2nd vertex. Press **[enter]**.
  - e) Move to a 3rd vertex. Press **[enter]**.
4. Press **[graph]** to open the F5 menu.
5. Highlight **Measure**, press the right cursor, and select **Angle**.
6. Measure one of the interior angles of the triangle.
  - a) Move the pencil to one of the vertex points. Press **[enter]**.
  - b) Move the pencil to the vertex of the angle being measured. The vertex point will blink. Press **[enter]**.



- c) Move the pencil to the third vertex. Press [enter].

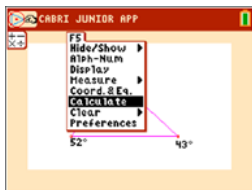
**Note:** The App will calculate and display the angle measurement near the angle being measured. To drag the numerical measurement to a desired location, use any of the  $\leftarrow$   $\rightarrow$   $\uparrow$   $\downarrow$  keys. Press [enter] when the angle measurement arrives at the desired location.

7. Repeat step 6 to find the angle measurements of the other two interior angles of the triangle.

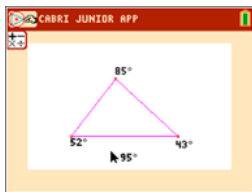


8. Calculate the sum of the three interior angles.

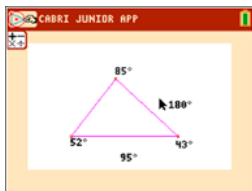
- a) Press **graph** to open the F5 window.  
 b) Select **Calculate**.  
 c) Move the arrow to one of the numerical angle measurements. The number will begin blinking when the angle is selected. Press [enter].  
 d) Press  $\oplus$  key from the keypad.  
 e) Move the arrow to another angle measurement until it starts blinking. Press [enter].



- f) The sum of the two angles selected will be output and you can drag them by using the  $\leftarrow$   $\rightarrow$   $\uparrow$   $\downarrow$  keys. Move the new calculation to a desired location and press [enter].  
 g) Point to the new calculation until it starts blinking (sum of the 2 angles) and press [enter] to select it.



- h) Press the  $\oplus$  key.  
 i) Move the arrow to the measurement for the unselected 3rd angle. Press [enter].  
 j) The calculation output will represent the sum of all three interior angles. Move the new calculation to a desired location and press [enter].

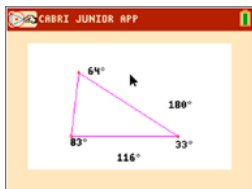


9. Press **clear** to stop the measurement tool and move the arrow to one of the three triangle vertices. The arrow will become "hollow" to indicate that the vertex being selected.

10. Press the **[alpha]** key once, and use any of the **[←]**, **[→]**, **[↑]**, **[↓]** keys to drag the vertex to a different location.

**Note:** When the arrow is near a geometric object, press **[alpha]** to turn the arrow into a hand icon so that you can drag the object.

Notice that the angle measurements change accordingly as the triangle changes shape, but their sum is always the same.



## Menus and Functions

The menus are labeled F1-F5 and correspond to the graphing keys directly below the screen. You can press the graphing keys (**[y=]**, **[window]**, **[zoom]**, **[trace]**, **[graph]**) for the corresponding function keys, or you can press **[alpha]** plus one of the function keys (**[f1]** - **[f5]**) to open the menu.

**Tip:** When the arrow is near a geometric object, press **[alpha]** to turn the arrow into a hand icon so that you can drag the object.

Menus	Functions
<b>F1 – File Menu</b>	
Animate	Set a point or points in motion along an object, as well as all objects logically depending on it.
Undo	
Undo	Undo the last action. This functionality is available as long as the current figure does not contain more than 128 objects.
Explore	Explore a figure by replaying (forward or backward) each step in drawing the figure. You can also use this feature to undo multiple steps that you took to draw a figure.
Help	
About	App version number information.
F1: File	Built-in help for using the F1 menu.
F2: Creation	Built-in help for using the F2 menu.
F3: Construction	Built-in help for using the F3 menu.
F4: Transform.	Built-in help for using the F4 menu.
F5: Appearance	Built-in help for using the F5 menu.
New	Create a new file.
Open...	Open a file.
Save	Save a file.

Menus	Functions
Save as...	Save a file with a new name.
Quit	Quit the application.
<b>F2 – Creation Menu</b>	
Point	
Point	Draw a point at any location.
Point on	Draw a point on an object.
Intersection	Draw an intersection point.
Line	Draw a line from new locations or existing points.
Segment	Draw a segment from new locations or existing points.
Circle	Draw a circle from new locations or existing points.
Triangle	Draw a triangle from new locations or existing points.
Quad.	Draw a quadrilateral from new locations or existing points.
<b>F3 – Construction Menu</b>	
Perp.	Draw a perpendicular line 1) with respect to another object or 2) draw the line through a given point with respect to another object.
Parallel	Draw a parallel line 1) with respect to another object or 2) draw the line through a given point with respect to another object.
Perp. Bis.	Draw the perpendicular bisector of a line segment that you select or draw a line that is the perpendicular bisector between two points, when the line segment between the two points has not been drawn.
Angle Bis.	Select three points of a triangle to draw an angle bisector.
Midpoint	Draw the midpoint of two points or the midpoint of a line segment.
Compass	Draw a circle using the compass tool.
Locus	Build the locus of an object that depends on a point located on a segment, line, or circle.
<b>F4 – Transformations Menu</b>	
Symmetry	Select the center point of symmetry, and then select the object. The new object is drawn.
Reflection	Select the line or segment about which the object will be reflected. Select the object to reflect. The object is reflected.



Menus	Functions
Translation	Select either a line segment or two points, and then select the object. A new translated object is created.
Rotation	Select the point around which an object will be rotated, and then select the object to rotate. Select the three points that determine the angle of rotation. A new rotated object is created.
Dilation	Select the object, select the point, and then select the dilation factor. A new dilated object is created.

#### F5 – Appearance Menu

Hide/Show	
Object	Hide or show an object.
Axes	Hide or show the axes.
Alph-Num	Label points, enter comments, and enter numerical values.
Display	Control the display of objects by toggling between solid and dotted outlines. Toggle the equation of a circle between the two forms.
Measure	
D. & Length	Find the distance between two points; length of a line segment; perimeter of a triangle or quadrilateral; or the circumference of a circle.
Area	Compute the area of a triangle, quadrilateral, or circle.
Angle	Measure angles (in degrees) determined by three points, the second of which is the vertex of the angle. The angle measured is the interior angle.
Slope	Find the slope of a line segment or line. If the slope is too large to be displayed numerically, ### is displayed instead.
Coord.&Eq.	Display coordinates of points and equations of lines and circles, in the underlying system of axes.
Calculate	Perform calculations using values that are displayed on the drawing screen. You can add, subtract, multiply, and divide numbers, as well as take the square root of a number.
Clear	
Object	Clear an object.
All	Clear the entire screen.
Preferences	Set color for point, line, segment, circle, triangle, quadrilateral, axes, and locus.

## Error Messages

Error Message	Description
Not Enough Memory! Add. RAM needed.	Cabri™ Jr. needs at least 4802 free bytes to run (roughly 5k). The dialog box indicates how much more free memory you need to be able to run Cabri™ Jr. It is possible to make more RAM or Flash memory available to Cabri™ Jr., by removing files stored in RAM or in Flash. Refer to the calculator manual for more information.
Continue without Undos?	When more than 128 objects have been drawn, Undo must be disabled to continue. After this error message is displayed, a dialog box asks if you want to continue. If you continue, Undo is disabled  Undo will be automatically re-enabled if the number of objects becomes lower than 128.
Max. object# reached.	Cabri™ Jr. figures can have a maximum of 256 objects.
Not Enough Memory! to save file.	When this message displays, the current figure is not lost. You can save the figure by: <ul style="list-style-type: none"><li>• Quitting Cabri™ Jr. and deleting some files to create additional free RAM (5K should be enough). You must not delete the AppVar CurrCaJ2; it contains the current figure.</li><li>• Saving CurrCaJ2 on your computer or another unit, and making use of it later when you have enough available RAM on your device.</li></ul>
No figure to open!	You have selected <b>Open</b> from the F1 menu, but there are no saved figures on your calculator to open.
Name already exists! Continue anyway?	You have entered a file name for your figure that already exists. Select <b>OK</b> to overwrite the existing file, or select <b>No</b> to return to the Save dialog box so that you can enter a different file name.
CURRCAJU is reserved	You cannot use or CURRCAJU or CURRCAJ2 as a file name. They are reserved AppVar names.
Figure abc not re-archived!	This happens, under tight Flash RAM conditions, when you have worked with an archived figure and made it significantly larger. In this case, you may not have enough memory to save the figure in Flash RAM, so the App saves it as a regular AppVar in RAM.
Batteries too low to access archived files!	The batteries in your calculator are low, so the App cannot save the file into Flash RAM . You can save the file without archiving it, then change the batteries and archive the file later.

# Using CellSheet™ App

The CellSheet™ application combines spreadsheet functionality with the power of a graphing calculator. Using the CellSheet™ application, you can:

- Create spreadsheets using
  - Integers
  - Real numbers
  - Formulas
  - Variables
  - Text and numeric strings
  - Functions
- Create cell formulas
- Use built-in functions
- Create spreadsheets containing 999 rows and 26 columns
- Enter data that is limited only by the available memory (RAM)

## Example Activity – Simple Compound Interest

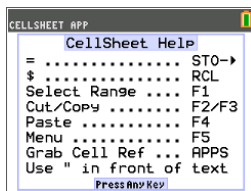
Use this activity to learn the basics of the App.

1. Press **[apps]**.
2. Choose **CellSheet** from the **APPLICATIONS** menu. The splash screen will appear.
3. Press any key other than **[2nd]** **[quit]** to dismiss the splash screen.

The Help screen will appear.

The function keys enable spreadsheet functionality (**Select Range**, **Cut**, **Copy**, **Paste**, and **Menu**).

The **[sto→]** and **[rc1]** keys are overwritten to provide quick access to common spreadsheet characters (= to start formula, \$ to add absolute reference).

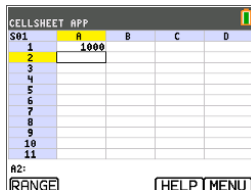
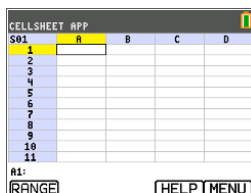


CellSheet Help	
ACTION	PRESS THIS KEY
=	<b>[sto→]</b>
\$	<b>RCL [2nd] [rc1]</b>
Select Range	<b>[f1]</b>
Cut	<b>[f2]</b>
Copy	<b>[f3]</b>
Paste	<b>[f4]</b>
Menu	<b>[f5]</b>
Grab Cell	<b>[apps]</b>
Press Any Key	

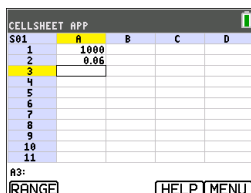
- Press any key for the spreadsheet to appear.  
The edit line with the cell reference appears on the left side.  
**The Menu soft key appears above [F5], as listed on the CellSheet Help screen.**

**Note:**

- Press the arrows to show that the cursor moves from cell to cell. The cell reference at the left side of the edit line changes as the cursor moves around.
  - Use **[alpha]** with the arrow keys to move up/down/left/right one screen at a time.
  - Use the arrow keys to move into a row/column heading to select the entire row/ column or into the very top-left corner to show the file name on the edit line.
- Scroll to cell A1. Press [enter].  
The cursor is active on the edit line, and the Menu soft key disappears so you can use the entire edit line.
  - Type in a principal amount, for example: 1000.
  - Press [enter].
  - The cursor has moved down to cell A2. Now type in an annual interest rate, for example: 0.06. Press [enter].



- To create a column for time:
  - Scroll to cell B1 and type "YEAR (using the **[alpha]** key, or Alpha Lock **[2nd]** [A-lock], as needed).  
**Note:** You must add a quotation mark (") before the word YEAR. The quotation mark tells CellSheet to treat this as text rather than as a variable.
  - Press [enter].



7. To designate time periods using a formula:
  - a) In cell B2, press **[1]** to designate year 1.
  - b) Press **[enter]** to move to cell B3.
  - c) Press **[enter]** to move the cursor to the edit line.
  - d) Type the first formula =B2+1. (See shortcut keys on screen for = sign **[f4]**.)
  - e) Press **[enter]**.  
The cell should return the value 2 for year 2.
  - f) Press the up arrow to see that the formula is still on the edit line for that cell.  
**Note:** You can copy the formula down the column. See CellSheet Help for copy **[f3]** select range **[f1]**, and paste **[f4]** shortcut keys.

S01	A	B	C	D
1		1000 YEAR		
2		0.06		
3				
4				
5				
6				
7				
8				
9				
10				
11				

B2: [ ]  
RANGE [ ] (HELP | MENU)

S01	A	B	C	D
1		1000 YEAR		
2		0.06		
3				
4				
5				
6				
7				
8				
9				
10				
11				

B3: =B2+1  
" \$ = FUNCS

8. Create a sequence using the **Sequence** option from the **Options** menu:
  - a) Press **[v]** to move to B4.
  - b) Press **[f5]** to open the MENU.
  - c) Choose **3:Options...**, then **3:Sequence...**.  
The input screen will appear.
  - d) Fill in the fields as indicated in the screen.
  - e) Scroll to the **Enter** area.
  - f) Press **[enter]**.  
A sequence from 3 to 10 fills in from cell B4 down.

CELLSHEET APP  
SEQUENCE  
1st Cell: B4  
seq(X,X,3,10)  
Down Right  
Enter

CELLSHEET APP  
SEQUENCE  
1st Cell: B4  
seq(X,X,3,10)  
Down Right  
Enter

9. Create a column for the balance.
  - a) Press the **[left]** and **[right]** keys to scroll to cell C1 and type "BAL (using the **[alpha]** key, or Alpha Lock **[2nd]** **[A-lock]**, as needed).
  - b) Press **[enter]**.

S01	A	B	C	D
1		1000 YEAR		
2		0.06	1	
3			2	
4			3	
5			4	
6			5	
7			6	
8			7	
9			8	
10			9	
11			10	

B4: 3  
RANGE [ ] (HELP | MENU)

10. For the balance at the end of year 1:

- In cell C2, press [enter] to move the cursor to the edit line.
- Enter the formula  $=\$A\$1*(1+\$A\$2)^B2$ .  
**Note:** You must use the \$ signs, because in order to copy the formula down the column, you need to create an absolute reference to cells A1 and A2 to make sure that the original principal and interest rate are the same in every copied formula. (See shortcut keys on screen for = sign [f4] and \$ [f3] when editing a cell.)
- Press [enter].

S01	A	B	C	D
1	1000	YEAR	BAL	
2		.06	1	
3			2	
4			3	
5			4	
6			5	
7			6	
8			7	
9			8	
10			9	
11			10	

C1: "BAL"      "    \$    =    [FONCT]

To watch the balance grow over time, copy cell C2 and paste it to the range C3:C11 as follows:

11. To copy cell C2:

- With cursor in cell C2, press RANGE [f1].
- Press COPY [f3].

S01	A	B	C	D
1	1000	YEAR	BAL	
2		.06	1	1060
3			2	
4			3	
5			4	
6			5	
7			6	
8			7	
9			8	
10			9	
11			10	

C2: =\$A\$1\*(1+\$A\$2)^B2  
 RANGE      [HELP MENU]

12. To select the range:

- Press the  key to scroll to cell C3.
- Press RANGE [f1] to choose a range to copy to (not shown).
- Press the  key to select the cells in the range from C3:C11.
- Press PASTE [f4] to paste to this range.

S01	A	B	C	D
1	1000	YEAR	BAL	
2		.06	1	1060
3			2	
4			3	
5			4	
6			5	
7			6	
8			7	
9			8	
10			9	
11			10	

C3:  
 RANGE      [HELP MENU]

13. After watching the balance grow, experiment by changing the interest rate in cell A2. Simply scroll to cell A2, change the number, and watch all of the balance values update. You can also experiment by changing the principal.

S01	A	B	C	D
1	1000	YEAR	BAL	
2		.06	1	1060
3			2	1123.6
4			3	1191
5			4	1262.5
6			5	1338.2
7			6	1418.5
8			7	1503.6
9			8	1593.8
10			9	1689.5
11			10	1790.8



C3:C11      PASTE [MENU]

C11: =\$A\$1\*(1+\$A\$2)^B11  
 RANGE      [HELP MENU]

## Menus and Functions



- To display the CELLSHEET MENU, select **Menu** (press [f5]).
- To display a help screen for common tasks, select **Help** from the CELLSHEET MENU.
- To exit the application, select **Quit CellSheet** from the CELLSHEET MENU.
- Press **clear** or **2nd** [quit] to:
  - Return to the main menu from a submenu.
  - Return to the spreadsheet from the main menu.

Menus	Functions
<b>File Menu</b>	
1: Open...	Opens an existing spreadsheet file.
2: Save As...	Saves the current spreadsheet with the same name or with a different name.
3: New...	Creates a new spreadsheet and allows you to use a new or existing name.
4: Delete...	Deletes a spreadsheet. You cannot delete the currently open spreadsheet.
5: Format...	Sets up formatting options. (Default values are highlighted.) AutoCalc: <b>Y</b> N Cursor Mvmt: <input type="checkbox"/> <input checked="" type="checkbox"/> Init Help: <b>Y</b> N Show: <b>FMLA</b> VALUE
6: Recalc	Recalculates the spreadsheet (only needed when the autocalculation feature in the FORMAT menu is turned off).
<b>Edit Menu</b>	
1: Go To Cell...	Moves the cursor to a specific cell.
2: Undelete Cell	Retrieves the contents of the cell that you just deleted or cleared.
3: Clear Sheet...	Deletes all data from the current spreadsheet.
4: Select Range...	Selects a range of cells.
5: Cut	Cuts the contents and formulas from the currently selected cell, or range of cells, and places them on the clipboard. Shortcut key: [f2]
6: Copy	Copies the contents and formulas from the currently selected cell, or range of cells, and places them on the clipboard. Shortcut key: [f3]

Menus	Functions
7: Paste	Pastes the contents and formulas that were just cut or copied to the clipboard into the current cell. Shortcut key: [f4]
<b>Options Menu</b>	
1: Statistics...	Calculates linear regression for the currently selected cell range. 1: 1-variable statistics 2: 2-variable statistics 3: Linear Regression - LinReg(ax+b)
2: Fill Range...	Fills a range of cells with a formula, number, or text.
3: Sequence...	Fills a range of cells with a sequence of numbers. 1st Cell: seq( DownRight
4: Import/Export ...	Imports and exports calculator files such as lists, matrices, or variables.
5: Sort...	Sorts a range of cells in ascending or descending order.
6: Col Decimal...	Sets the decimal mode display for a column. The calculator decimal mode display (accessed by pressing <b>mode</b> ) does not affect the CellSheet™ application.
<b>Charts Menu</b>	
1: Scatter...	Displays a scatter chart for a range of cells. XRange: YRange 1: YRange 2: YRange 3: Title: AxesOn AxesOff DrawFit Draw <b>Notes:</b> <ul style="list-style-type: none"> <li>You can set the color of the graph using the color spinner in the left column. After you enter a range, move the cursor to the color spinner and press [enter]. Next, use  to select a new color. Press  to set the new color.</li> <li>DrawFit Autoscales the graph of the chart. Draw uses the chart window settings in the CellSheet Chart menu (not the Operating System Window settings) to graph the</li> </ul>



Menus	Functions
2: Scatter Window	<p>chart.</p> <p>Displays the parameters for the viewing window for the scatter chart so that you can change the values.</p> <p>Xmin=  Xmax=  Xscl=  Ymin=  Ymax=  Yscl=  <b>Draw</b> Save</p>
3: Line...	<p>Displays a line chart for a range of cells.</p> <p>XRange:  YRange 1:  YRange 2 :  YRange 3:  Title:  <b>AxesOn</b> AxesOff  <b>DrawFit</b> Draw</p> <p><b>Notes:</b></p> <ul style="list-style-type: none"> <li>You can set the color of the graph using the color spinner in the left column. After you enter a range, move the cursor to the color spinner and press [enter]. Next, use <input type="button" value="◀"/> to select a new color. Press <input type="button" value="▶"/> to set the new color.</li> <li>DrawFit Autoscales the graph of the chart. Draw uses the chart window settings in the CellSheet Chart menu (not the Operating System Window settings) to graph the chart.</li> </ul>
4: Line Window...	<p>Displays the parameters for the viewing window for the line chart so that you can change the values.</p> <p>Xmin=  Xmax=  Xscl=  Ymin=  Ymax=  Yscl=  <b>Draw</b> Save</p>
5: Bar...	<p>Displays a bar chart for a range of cells.</p> <p>Categories:  Series1:</p>

Menus	Functions
	Ser1Name: Series2: Ser2Name: Series3: Ser3Name: Title: Vertical Horiz DrawFit Draw <b>Notes:</b> <ul style="list-style-type: none"> <li>You can set the color of the graph using the color spinner in the left column. After you enter a range, move the cursor to the color spinner and press [enter]. Next, use  to select a new color. Press  to set the new color.</li> <li>Vertical Horiz display the bars in specified directions.</li> <li>DrawFit Autoscales the graph of the chart. Draw uses the chart window settings in the CellSheet Chart menu (not the Operating System Window settings) to graph the chart.</li> </ul>
6: Bar Window	Displays the parameters for the viewing window for the bar chart so that you can change the values. Barmin= Barmax= <b>Draw</b> Save
7: Pie...	Displays a pie chart for a range of cells. Categorieis: Series: <b>Number</b> Percent Title: Draw:

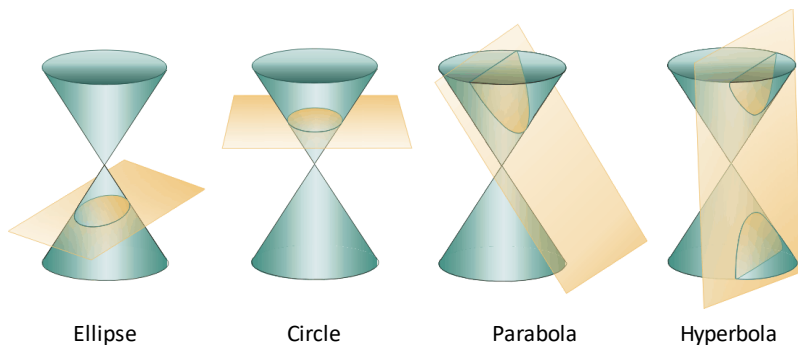
## Error Messages

Error Message	Description
INVALID CELL, INVALID RANGE.	This occurs when you type in an invalid cell or a range such as A0, BZ12, or A1:A1000. Valid cells are A1 to Z999.
CIRCLE REF	This occurs when the logic of cell formulas results in a loop, for example when A1 is set to =A1.
CANNOT SORT	The CellSheet™ application does not sort ranges that contain formulas.
INVALID NAME	The name that you entered is too long, or contains characters that are invalid.

Error Message	Description
INVALID LIST, INVALID MATRIX, INVALID VAR	The list name, matrix name, or variable name does not exist.
SYNTAX	This occurs when you enter an invalid cell reference (e.g., A0), or if you delete a cell that is referred to by another cell.

# Using Conic Graphing App

This App presents equations in function, parametric, or polar form and provides a simple way to graph the four conic shapes:



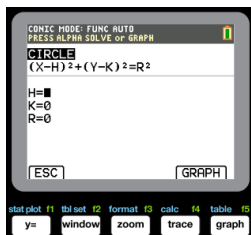
Enter the required parameters to graph, trace or solve for the conic's characteristic.

## Example Activity – Conic Graphing

**Tip:** Options display at the bottom of the screen to help you navigate and perform specific tasks.

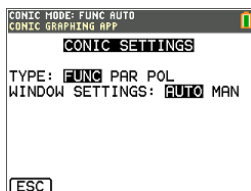
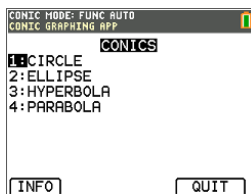
To select one of these options, press the graphing key directly below it.

For example, to select [ESC], press  $\boxed{y=}$ .



## Conic Graphing App - Basics

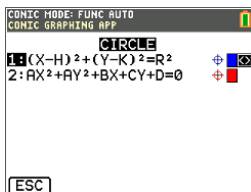
1. Select the App by pressing the  $\boxed{\text{apps}}$  key and selecting **Conics**.
2. Press any key to clear the splash screen.
3. Press  $\boxed{\text{mode}}$  and ensure the window setting is **AUTO**.
4. Press [ESC] to return to the main menu.
5. Press [enter] or  $\boxed{1}$  to select circle.



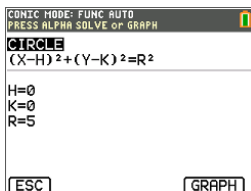
## Circle in (X,Y) Form

Here are the two equations for a circle in the X,Y form.

1. Select Equation 1 by pressing  $\boxed{1}$ .  
**Note:** You may change the color of the circle by pressing the  $\boxed{\leftarrow}$   $\boxed{\rightarrow}$  keys.

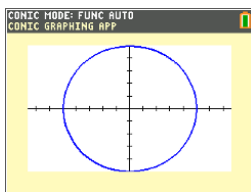


2. Enter H=0, K=0, and R=5.
3. Press  $\boxed{\text{GRAPH}}$ .  
The circle is displayed.



4. Press the  $\boxed{\text{clear}}$  key to go back to the CIRCLE parameter entry screen.
5. Press  $\boxed{\text{trace}}$  to show the points along the curve.

**Note:** Use the  $\boxed{\leftarrow}$   $\boxed{\rightarrow}$  keys to move along the curve.

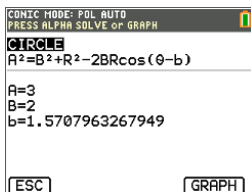
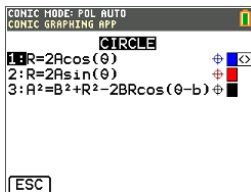


## Circle in Polar Form

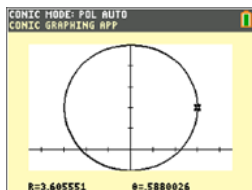
1. Continuing from the previous example, press  $\boxed{\text{mode}}$  to return to the CONICS SETTINGS menu (not shown).
2. Use the  $\boxed{\rightarrow}$  key to change the **CONIC SETTINGS TYPE** to **POL**.
3. Press  $\boxed{\text{ESC}}$  to display the equation screen.
4. Select equation 3.
5. Enter A=3, B=2, and  $b = \pi/2$ .

### Notes:

- $\pi/2$  is evaluated to 1.5707963267949.
- B and b are the polar form of the offsets.
- Fractions and MathPrint™ templates are not supported in the Conic Graphing App.



- Press **[graph]**.
- Press **[trace]** to show the points along the curve and note the different coordinate system used.  
**Note:** Use the **[←]** **[→]** keys to move along the curve.

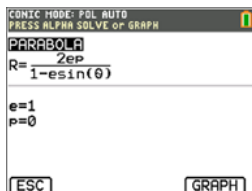


### Parabola in Polar Form

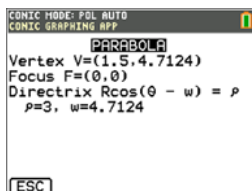
- From the circle, press **[ESC]** until you return to the main menu.  
Note: **[ESC]** does not appear on the graph screen but pressing **[y=]** behaves as **[ESC]**.
- Press **[4]** on the main CONIC screen for parabola options. The equations for parabolas in polar form are listed.
- Select equation **3**.
- Enter the eccentricity,  $e$ , of the parabola to **1**.
- Change the  $p$  value to be **1.5**.



- Press the **[alpha]** **[solve]** key. The context help line of the status bar displays **PRESS ALPHA SOLVE OR GRAPH**.  
**Note:** Here, the solutions to parabola specific terms are shown in polar form.

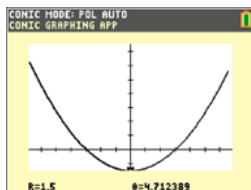


The solutions are computed in radian mode since the calculator setting is in radian mode.



- To recalculate in degree mode:
  - Quit the App. To quit the App, press **[2nd]** **[quit]**.
  - Press **[mode]**.
  - Use the **[v]** key until **RADIAN** is blinking.
  - Use the **[→]** key to change the mode setting to **DEGREE**.
  - Press **[enter]**.
- Re-enter the App.
- Repeat steps 2 and 3 above.
- Press **[alpha]** **[solve]** to show the difference.

11. Press the **trace** key and use the **←** **→** keys to move along the curve.



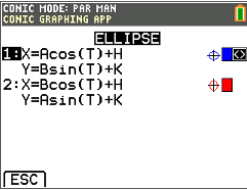
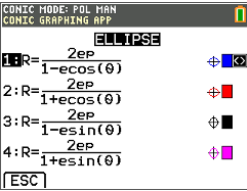
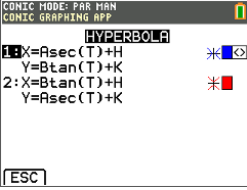
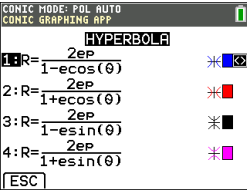
## Menus and Functions

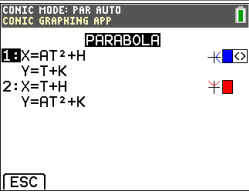
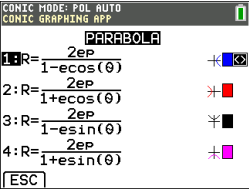
- To quit the application select [QUIT] from the CONICS main menu. From any CONICS screen, press **2nd** [quit] several times to quit the App and return to the home screen.
- Values you input in Conic Graphing are saved in an application variable (AppVar) when you exit the application. The next time you run the application, the last values you entered will display.

Menus/Menu Items	Description
<b>Conic Settings (Press <b>mode</b>)</b>	
Type	Select the calculator mode. FUNC: Function plots functions where Y is a function of X. PAR: Parametric plots relations where X and Y are functions of T. POL: Polar plots functions where R is a function of $\theta$
Window Settings	Select AUTO so that the windows change automatically. Select MAN so that you can manually change window settings.
Esc	Return to the previous screen.
<b>Main Menu</b>	
Circle	A circle is the set of points in a plane whose distance from a given fixed point in the plane is constant. The fixed point is the center of the circle; the constant distance is the radius.
Ellipse	An ellipse is the set of points whose distances from two fixed points in the plane have a constant sum. The two fixed points are the foci of the ellipse. The line through the foci of an ellipse is the ellipse's focal axis. The point on the axis halfway between the foci is the center. The points where the focal axis and ellipse intersect are the ellipse's vertices.
Hyperbola	A hyperbola is the set of points in a plane whose

Menus/Menu Items	Description
	distances from two fixed points in the plane have a constant difference. The two fixed points are the foci of the hyperbola. The line through the foci of the hyperbola is the focal axis. The point on the axis halfway between the foci is the hyperbola's center. The points where the focal axis and hyperbola cross are the vertices.
Parabola	A set that consists of all the points in a plane equidistant from a given fixed point and a given fixed line in the plane is a parabola. The fixed point is the focus of the parabola. The fixed line is the directrix. The point where the focal axis intersects the parabola is the vertex.
Info	Display the information screen, which contains the application version number.
Quit	Select QUIT to exit Conic Graphing.
Esc	Select ESC to go back one screen.
<b>Circle Menu</b>	
$(X-H)^2 + (Y-K)^2 = R^2$	In FUNC mode, select this equation and input H, K and R.
$AX^2 + AY^2 + BX + CY + D = 0$	In FUNC mode, select this equation and input A, B, C and D.
$X=R\cos(T)+H$ $Y=R\sin(T)+K$	In PAR mode, select this parametric equation and input H, K and R.
1: $R=2A\cos(\theta)$	In POL mode, select this polar equation and input A.
2: $R=2A\sin(\theta)$	In POL mode, select this polar equation and input A.
3: $A^2=B^2+R^2-2BR\cos(\theta-b)$	Select this polar equation and input A, B and b.
[GRAPH]	Select to graph the equation.
$\alpha$ [solve]	Display the center and radius.
$\text{trace}$	Trace the circle.
<b>Ellipse Menu</b>	
1: $\frac{(X-H)^2}{A^2} + \frac{(Y-K)^2}{B^2} = 1$	In FUNC mode, select this equation and input A, B, H and K.
2: $\frac{(X-H)^2}{B^2} + \frac{(Y-K)^2}{A^2} = 1$	In FUNC mode, select this equation and input A, B, H and K.



Menus/Menu Items	Description
	<p>In PAR mode, select this parametric equation and input A, B, H and K.</p> <p>In PAR mode, select this parametric equation and input A, B, H and K.</p>
	<p>In POL mode, select this polar equation and input e and p.</p> <p>In POL mode, select this polar equation and input e and p.</p> <p>In POL mode, select this polar equation and input e and p.</p> <p>In POL mode, select this polar equation and input e and p.</p>
[GRAPH]	Select to graph the equation.
[alpha] [solve]	Display the center and foci.
[trace] [ ]	Trace the orbit.
<b>Hyperbola Menu</b>	
<p>1: <math>\frac{(X-H)^2}{A^2} - \frac{(Y-K)^2}{B^2} = 1</math></p> <p>2: <math>\frac{(Y-K)^2}{A^2} - \frac{(X-H)^2}{B^2} = 1</math></p>	<p>In FUNC mode, select this function equation and input A, B, H and K.</p> <p>In FUNC mode, select this function equation and input A, B, H and K.</p>
	<p>In PAR mode, select this parametric equation and input A, B, H and K.</p> <p>In PAR mode, select this parametric equation and input A, B, H and K.</p>
	<p>In POL mode, select this polar equation and input e and p.</p> <p>In POL mode, select this polar equation and input e and p.</p> <p>In POL mode, select this polar equation and input e and p.</p>

Menus/Menu Items	Description
	In POL mode, select this polar equation and input e and p.
[GRAPH]	Select to graph the equation.
[alpha] [solve]	Display the center, vertices, foci, and slope of the asymptotes.
[trace] [ ]	Trace the hyperbola.
<b>Parabola Menu</b>	
1: $(Y-K)^2 = 4P(X-H)$	In FUNC mode, select this function equation and input A, B, H and K.
2: $(X-H)^2 = 4P(Y-K)$	In FUNC mode, select this function equation and input A, B, H and K.
	In PAR mode, select this parametric equation and input A, H and K.
	In PAR mode, select this parametric equation and input A, H and K.
	In POL mode, select this polar equation and input e and p.
	In POL mode, select this polar equation and input e and p.
	In POL mode, select this polar equation and input e and p.
	In POL mode, select this polar equation and input e and p.
[GRAPH]	Select to graph the equation.
[alpha] [solve]	Display the vertex, focus, and directrix.
[trace] [ ]	Trace the trajectory.

## Error Messages

### All Equations

Error Message	Description
The curve does not display correctly, or a partial curve	The parameters you entered may be outside of the acceptable range for the calculator. If you changed the <b>CONIC SETTINGS</b> window settings mode to

Error Message	Description
displays.	<b>MAN</b> , press <b>zoom</b> and select <b>Zoom Conic</b> to redefine the window settings.
Window range error or zoom error.	Change the window parameters ( <b>Xmin</b> , <b>Xmax</b> , <b>Ymin</b> , <b>Ymax</b> ) so that the window is larger or smaller, depending on the graph.
Invalid input	Change the input to a valid value.
Requested zoom has invalid results.	Change the window parameters ( <b>Xmin</b> , <b>Xmax</b> , <b>Ymin</b> , <b>Ymax</b> ) or <b>Xfact</b> and <b>Yfact</b> zoom factors. You must exit Conic Graphing to change the <b>Xfact</b> and <b>Yfact</b> zoom factors.
Invalid AppVar CONICSD. Please remove.	The application variable (AppVar) named CONICSD has been corrupted or another application variable uses the same name. Delete the AppVar, or use TI Connect™ CE Software to remove it and save it on your computer.
Error saving Conics settings.	The AppVar CONICSD cannot be modified. Delete the AppVar, or use TI Connect™ CE Software to remove it and save it on your computer.

### Circles

Error Message	Description
Allowed parameter values: $R \geq 0$ .	Change the parameter so that $R \geq 0$ .
Allowed parameter values: $A \geq 0$ .	Change the parameter so that $A \geq 0$ .
Values out of range for computation. Recheck window settings.	Change the parameter so that $b < 1E12$ (occurs only in polar mode in equation 3).
Parameters create a non-real answer.	Change the parameters so that for the equation $AX^2+AY^2+BX+CY+D=0$ , the following is satisfied: $\sqrt{(-D/A) + (B/2A)^2 + (C/2A)^2} \geq 0$

### Ellipses

Error Message	Description
Allowed parameter values: $0 < A < B$ .	Change the parameter so that $A > B$ and $B > 0$ .
Values out of range for computation. Recheck window settings.	Change the parameter so that $0 < A < 1E50$ .
Allowed parameter values: $0 < e < 1$ .	Change the parameter so that $e > 0$ and $e < 1$ .

Error Message	Description
Allowed parameter values: $p \neq 0$ .	Change the parameter so that $p < 0$ or $p > 0$ .

### Hyperbolas

Error Message	Description
Values out of range for computation. Recheck window settings.	<p>If the calculator is in <b>FUNC</b> or <b>PAR</b> mode, change the parameters so that</p> $\text{that } \frac{A}{B} \text{ or } \frac{B}{A} < 1 \epsilon 100 \text{ or}$ $\frac{A}{B} \text{ or } \frac{B}{A} > 1 \epsilon -100.$ <p>If the calculator is in <b>POL</b> mode, change the e or p parameter so that <math>e^2</math> or <math>ep &lt; 1E100</math>.</p>
Allowed parameter values: $A > 0$ .	Change the parameter so that $A > 0$ .
Allowed parameter values: $B > 0$ .	Change the parameter so that $B > 0$ .
Allowed parameter values: $e > 1$ .	Change the parameter so that $e > 1$ .
Allowed parameter values: $p \neq 0$ .	Change the parameter so that $p < 0$ or $p > 0$ .
Window range error or zoom error.	Change the window characteristics or change P so that the values involved in the calculation do not exceed the calculator's limitations.

### Parabolas

Error Message	Description
Allowed parameter values: $A \neq 0$ .	Change the parameter so that $A < 0$ or $A > 0$ .
Allowed parameter values: $p \neq 0$ .	Change the parameter so that $p < 0$ or $p > 0$ .
Window range error or zoom error.	Change the window parameters ( <b>Xmin</b> , <b>Xmax</b> , <b>Ymin</b> , <b>Ymax</b> ) and/or the p value.
Values out of range for computation. Recheck window settings.	Change the window parameters ( <b>Xmin</b> , <b>Xmax</b> , <b>Ymin</b> , <b>Ymax</b> ) and/or the p value.

# Using Vernier EasyData™ CE App

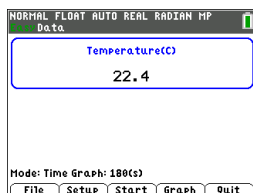
The EasyData™ CE App from Vernier Software & Technology enables single-sensor data collection. The App auto-launches data collection when you connect supported Vernier sensors to the mini-USB port on the graphing calculator. Built-in analysis and experiments for supported Vernier sensors are available. Vernier EasyData™ supports data collection with the CBR 2™ Motion Detector, the Vernier EasyTemp™ sensor, and other Vernier sensors that use the Vernier EasyLink™ adapter.

For more information on compatible Vernier sensors, visit the Vernier sensor wizard.

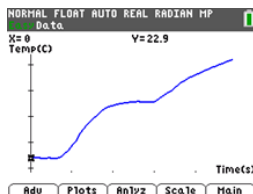
## Example Activity - Vernier EasyData™

Use this activity to learn the basics of the App.

1. Connect the Vernier EasyTemp™ sensor to the calculator. After a few seconds, the Vernier EasyData™ main screen displays. This main screen shows the current Vernier EasyData™ mode and the current sensor reading in a meter format.
2. Select **Start** to start collecting data, and then wait five seconds.
3. Hold the tip of the Vernier EasyTemp™ sensor for about 30 seconds. The graph shows the temperature as it changes.



4. Select **Stop** to stop collecting data. Vernier EasyData™ displays a scaled graph of the sampled temperatures.
5. Press  $\square$  repeatedly to scroll the cursor to the right, and note the temperature at each data point.
6. When you finish exploring the graph, select Main to return to the Vernier EasyData™ main screen.



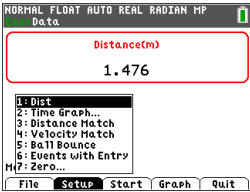
**Tip:** On the graph screen, select [Anlyz] ( $\square$ ) to see all the features to analyze the data.

**Tip:** On the main screen with the sensor reading in meter format, press [Setup] ( $\square$ ) to choose activities designed for the connected sensor.

7. Select **Quit**. A message indicates that Vernier EasyData™ has stored the collected data in calculator lists.

## Menus and Functions

To quit the App, press [Quit] ( $\square$ ).

Menus	Functions
<b>Main Menu</b>	
File	Save the data from an experiment or select <b>New</b> and Vernier EasyData™ App restarts in the default data-collection mode, and the default settings are restored.
Setup	<p>Set up the experiment.</p> <p>The menu will differ depending on the sensor. For example, for connected CBR 2™ motion detector, the setup menu displays as follows:</p> 
Time Graph	Open the <b>Time Graph Settings</b> wizard.
Sample Interval	Set the interval in seconds. Select <b>Next</b> to go to the next setting.
Number of Samples	Set the total number of samples to collect.
Experiment Length	Set the length of the experiment in seconds.
Edit	Edit the time graph settings.
Cancl	Cancel your changes and return to the previous settings.
OK	Return to the main menu.
Events with Entry	Capture samples manually for a set of events that you define. Each sampled value becomes a y-value; you enter the x-value.
Keep	Capture the current sampled (y) value.
Enter value	Assign an x-value to define the data point. Then select <b>OK</b> .
Stop	Select Stop to end the experiment. The data points are displayed as a graph (a calculator scatter plot).
Main	Return to the main menu.
Zero	Use the current data reading as a zero reference.
Start	Start collecting data.
Stop	Stop collecting data. A scaled graph of the collected data appears.

Menus	Functions
Main	Return to the main menu.
Graph	Graph the resulting equation.
Adv	Select independent and dependent lists to plot various views of the data.
Plots	Plot options such as distance vs. time, velocity vs. time, and acceleration vs. time (dependent on sensor connected).
Anlyz	Computes statistics on data collected and finds a variety of regression fit to data (dependent on sensor connected).
Scale	Options to auto-fit or manually edit the graph scaling.
Quit	Quit the application. The collected data has been transferred to the calculator's lists.

### **Error Messages**

Error Message	Description
<b>No Interface Connection</b>	<ul style="list-style-type: none"> <li>Firmly connect cables.</li> <li>Check the power.</li> <li>Choose Scan to retry.</li> <li>Choose None to continue without the interface.</li> <li>Choose Quit to exit the App.</li> </ul> <p>The calculator could not recognize a valid connection to the data collection device. Make sure a sensor is connected. Check all physical connections, power supply, and device batteries. Restore the default settings: On the Vernier EasyData™ App main screen, select <b>File</b>, and then select <b>New</b>.</p>
<b>No Data</b>	<ul style="list-style-type: none"> <li>A graph cannot be drawn because the data lists are empty.</li> </ul> <p>A graph plot was requested without collecting any data. You can display a graph only after you have run an experiment to store data in the calculator memory.</p>
<b>Communications Error</b>	<ul style="list-style-type: none"> <li>Firmly connect cables.</li> <li>Check the power.</li> <li>Choose <b>Field</b> to search for interface and sensors.</li> <li>Choose <b>Quit</b> to exit the App.</li> </ul> <p>Check all physical connections, power supply, and device batteries.</p>
<b>Memory Error</b> There is insufficient RAM to run the Vernier EasyData™	You need to delete items from the calculator memory.

Error Message	Description
App.	
<b>Battery Level</b> Calculator: Bad, please replace Data Collection Device: Good Battery Level Calculator: Good Data Collection Device: Bad, please replace.	Recharge calculator battery in the calculator or replace batteries in the data collection device.



# Using Inequality Graphing App

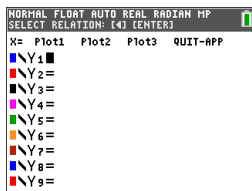
The Inequality Graphing App gives you new features for graphing equations and inequalities and evaluating the relationship between them. Using the Inequality Graphing application, you can:

- Enter inequalities using relation symbols
- Graph inequalities and shade the union and intersection regions
- Enter inequalities (vertical lines only) in an X=editor
- Trace points of interest (such as intersections) between relations
- Store (x,y) coordinate pairs to lists for viewing and optimizing functions for linear programming

## Example Activity – Inequality Graphing

Use this activity to learn the basics of the App.

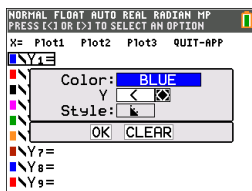
1. To begin:
  - a) Press **[apps]**.
  - b) Choose Inequalz.
  - c) Press any key to dismiss the splash screen.  
The cursor will blink over the = sign in the enhanced inequality Y=editor.



**Note:** The context help line of the status bar gives help such as :

**SELECT RELATION:** **[4]** [enter]. (See screen.)

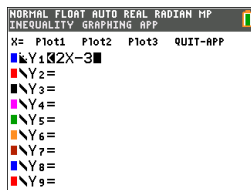
2. Press **[4]** [enter] to open the graph style dialog to select the relation.
3. Press **[v]** to move the cursor to Y.
4. Press **[l]** or **[r]** to change selections to "less than."
5. Press **[v]** to highlight **OK**.
6. Press [enter].



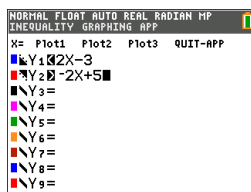
**Note:** The TI-84 Plus CE version of Inequality Graphing uses the same graph style setting dialog box as the operating system. The context help line of the status bar indicates **PRESS [<] OR [>] TO SELECT AN OPTION**.

The TI-84 Plus C version relation selection uses shortcuts F1-F5 to change the relation type.

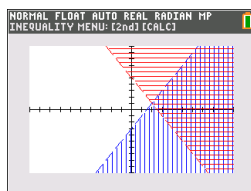
7. Press  $\rightarrow$  to move the cursor and enter  $Y_1 < 2x - 3$ .



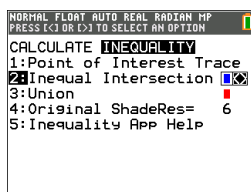
8. Repeat the steps above to change the relation of  $Y_2$  to "greater than" and enter  $Y_2 > -2X + 5$ .



9. Press  $\text{graph}$  to view the shaded inequalities.  
**Note:** The context help line of the status bar displays **INEQUALITY MENU:  $\text{2nd}$  [calc]**. This menu contains the tools for an inequality intersection and other features. The TI-84 Plus C version displays these tools as shortcut  $\text{F1}$ – $\text{F5}$  on the graph screen.

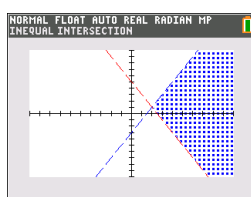


10. To find the intersection of the two inequalities:
- Press  $\text{2nd}$  [calc].
  - Press  $\rightarrow$  to select the INEQUALITY menu.
  - Select **2:Inequal Intersection**.



#### Notes:

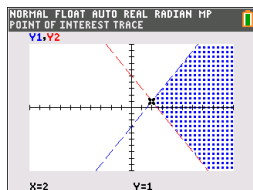
- You can change the color of the intersection by pressing  $<$  or  $>$  when the color spinner on the right of the screen is blinking.
- Use the features on the INEQUALITY menu to find Point of Interest Trace, which gives the intersection point(s) of the boundaries of the regions shaded.
- Use the Union feature on the INEQUALITY menu to display the union of the regions. Use Original Shade to display the original shading of the regions.



**Note:** The Inequality menu features are accessed with shortcut keys  $\text{F1}$ – $\text{F5}$  on the graph screen in the TI-84 Plus C version.

11. To examine the intersection of the boundaries of the two regions:

- Press  $\boxed{2nd}\boxed{[calc]}$ .
- Press  $\boxed{\rightarrow}$  to select the INEQUALITY menu.
- Select **1: Point of Interest Trace**.



#### Notes:

- Since both  $Y_1$  and  $Y_2$  are strict inequalities, the notation used in the expression area is  $Y_1, Y_2$ , which is called a point of interest. If point of interest is an intersection of a boundary included in the region, the notation will display the intersection symbol.
- If more than one point of interest is in the graph area, use the arrow keys to trace point to point. Not all points of interest may be located if boundaries are non-linear.

### Menus and Functions

- To quit the App, select the QUIT-APP option at the upper-right of the Y=screen. Select **2:Quit Inequal** at the prompt.
- Inequality Graphing App and Transformation Graphing App cannot run at the same time since they enhance the Function Mode of the  $\boxed{y=}$  editor. If the Apps are in conflict, follow the prompts to quit the conflicting App, which will allow the other App to run as an enhanced  $\boxed{y=}$  editor.

Menus	Functions
<b>Graph/Plot Setup Keys</b>	
Y=	Displays the Y= Editor, where you can enter one or more inequalities to graph and change the graph color and line style.
X=	Graph a vertical inequality.
Window	Set the viewing window to produce the best display of your graph.
Zoom	Quickly adjust the window to a pre-defined setting.
Trace	Move the cursor along the graphed function using $\boxed{\leftarrow}$ and $\boxed{\rightarrow}$ .
Graph	Display the graph you have defined.
<b>Inequality Menu</b>	
INEQUALITY	
1: Point of Interest Trace	Trace points of interest (such as intersections) between relations.

Menus	Functions
2: Inequal Intersection	Display the intersection of the inequalities and select the color of the shading.
3: Union	Display the combined area of the inequalities and select the color of the shading.
4: Original ShadeRes=	Return to the original inequality graph.
5: Inequality App Help	Help for Inequality Graphing.
<b>Quit Menu</b>	
1: Continue Running	Continue using the Inequality Graphing app.
2: Quit	Quit the App.
3: About	Display the opening screen with version number information.

## Error Messages

Error Message	Description
ERR: MEMORY 600 Bytes Free RAM Needed 1: Quit Inequal	The calculator does not have enough free RAM to create the INEQVAR AppVar. Delete some items to free at least 600 bytes of RAM.
Conflicting APPS 1: Quit Inequal 2: Quit Apps listed below	One or more applications that are currently running use the same resources as the Inequality Graphing application. To run the Inequality Graphing application, you must quit the conflicting application(s).
ERR: INEQVAR 1:Overwrite 2:Quit Inequal	An AppVar named INEQVAR already exists, but it is not related to this application. Select one of the following options: 1. Overwrite to overwrite the current AppVars. 2. Quit Inequal to quit the application. Inequality Graphing will not run without the correct version of INEQVAR. You must either rename the existing AppVar or let Inequality Graphing overwrite it.
ERR: Data Type 1: Quit 2: Goto	An X-variable (in the X=editor) evaluates to a number that is not real. Select one of the following options: 1. Quit to restore the previous value for that X-variable. 2. Goto to change the X-variable so that it evaluates to a real number.
ERR: Divide by 0 1:Quit 2:Goto	You have entered an expression on the Y=Editor or X=Editor that is divided by zero. Select one of the following options: 1. Quit to restore the previous value for that X-variable. 2. Goto to change the expression so that it evaluates to a real number.

# Using Periodic Table App

This App provides a graphical representation of the elements of the Periodic Table.

**Note:** This guide uses the CRC Handbook of Chemistry and Physics, 94th Edition.

For v5.5 and higher, selected elements have been updated using the Royal Society of Chemistry : <http://www.rsc.org/periodic-table> © Royal Society of Chemistry 2020.

This application allows you to:

- Observe and explore the Periodic Table of the Elements
- Find property data and useful information about the known elements
- Sort the elements by atomic number, alphabetically by name or alphabetically by symbol
- Identify groups of elements by region (noble gasses, halogens, etc.) and block (p-, d-, s- and f-)
- Export property data to lists for further analysis
- Graph the major properties (atomic radii, electronegativities, etc.) against atomic number to illustrate the periodic nature of the elements

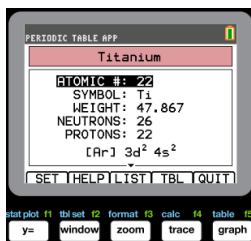
## Example Activity – Periodic Table

Use this activity to learn the basics of the App.

**Tip:** Options display at the bottom of the screen to help you navigate and perform specific tasks.

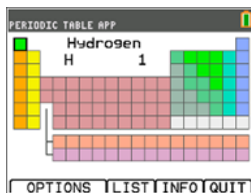
To select one of these options, press the graphing key directly below it.

For example, to select [TBL], press trace.



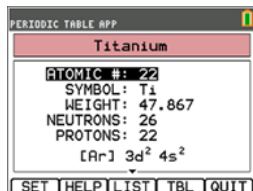
1. To begin:

- a) Press apps.
- b) Choose **Periodic** using the ▲ ▼ keys.
- c) Press any key to dismiss the splash screen.

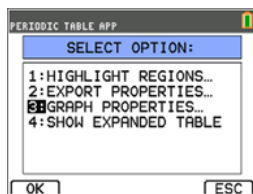


2. To find a specified element:

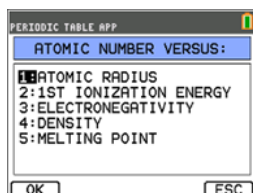
- a) Use ◀ ▶ ▲ ▼ to find the element.
- b) Press [enter].
- c) Use the ▲ ▼ keys to examine and explore 15 properties of the specified element.



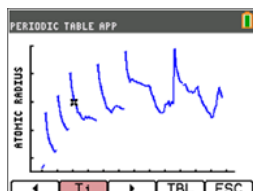
- Press **[TBL]** ( ) to return to the main Periodic Table screen.
- Press **[OPTIONS]** ( ).
- Choose **GRAPH PROPERTIES**.



- Choose **ATOMIC RADIUS**.



- Use **[←]** **[→]** to explore how atomic radius relates to each element (notice that the element symbol changes in one of the “soft keys”). This graph is patterned to show distinct regions; in this case, it shows the elements that occupy the lower points of each region.





- Press **[TBL]** ( ) to return to the Periodic Table main screen.
- Press **[QUIT]** ( ) to quit the app.

## Menus and Functions

- The app will continue running until it is turned off. Press **[apps]** and then select **Periodic**. Select **2: Quit Periodic**.

Menus	Functions
Periodic Table	
Options	Select the options menu.

Menus	Functions
List	Display the list of elements.
Info	Display the opening screen with the version number.
Quit	Exits the Periodic Table application.
<b>Option Menu</b>	
1: Highlight Regions...	Select one region to highlight on the Periodic Table. The regions are: ALL, ALKALI METALS, ALKALINE METALS, TRANSITION ELEMENTS, INNER-TRANSITION, HALOGENS, NOBLE GASES, METALLOIDS, NON-METALS, ACTINIDE SERIES, LANTHANIDE SERIES, and METALS
2: Export Properties...	Creates two lists, each with 118 items. ÜNUM, contains the atomic numbers for every element.
1: Atomic Radius	Select to create the second list ÜRAD..
2: 1st Ionization Energy	Select to create the second list ÜION.
3: Electronegativity	Select to create the second list ÜNEG.
4: Density	Select to create the second list ÜDEN
5: Melting Point	Select to create the second list ÜMP.
3: Graph Properties...	Select the property values included in a Y list. The calculator graphs the Y-list versus the constant X list labeled ATOMIC NUMBER.
1: Atomic Radius	Highlight one of the options as the Y-list and select <b>OK</b> to display the graph. Select <input type="checkbox"/> or <input type="checkbox"/> to trace the graph.
2: 1st Ionization Energy	
3: Electronegativity	
4: Density	
5: Melting Point	
4: Show Expanded Table	
S	Highlights the s-block of elements
D	Highlights the d-block of elements <input type="checkbox"/>

Menus	Functions
P	Highlights the p-block of elements 
F	Highlights the f-block of elements 
OK	Select the block.
ESC	Returns to the Periodic Table.
<b>Element Detail Screen</b>	
Set	While highlighting any numerical value on this menu, select SET to send the value to your calculator's home screen.
Help	Displays units of measurement and definitions.
List	Displays a <b>LIST</b> of the Periodic Table elements.
Tbl	Returns to the Periodic Table.
Quit	Exits the Periodic Table application.
<b>List Menu</b>	
Reset	Reset list to sort by the default setting: atomic number.
Sort	Sort the list by atomic number, name, or symbol.
Tbl	Returns to the Periodic Table.
Quit	Exits the Periodic Table application.



# Using Polynomial Root Finder & Simultaneous Equation Solver App

The Polynomial Root Finder & Simultaneous Equation Solver application:

- **Calculates the roots (zeros) of polynomials of degree 1 through 10, with a convenient, easy to use interface.**

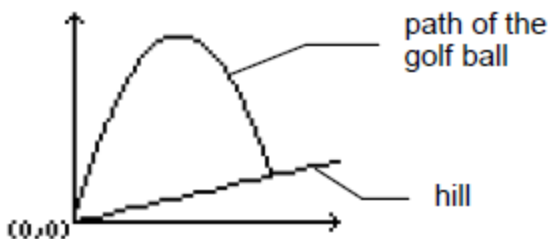
You can enter the coefficients to a polynomial to solve, store solutions into lists, load lists into the App as coefficients, and store the polynomial to a Y-Var to graph after quitting the App.

- **Finds solutions to systems of linear equations.**

You can enter a system of equations to solve, load matrices containing the coefficients of a linear system, and identify whether a given system has a unique solution, an infinite number of solutions, or no solution.

## Example Activity – Polynomial Root Finder

Use this activity to learn the basics of the App.



A golfer hits a golf ball from a tee at the bottom of a hill.

You can describe the hill by  $y(x) = 0.8x$ .

The ball follows the path  $y(x) = -x^2 + 12x$ .

If the golfer is standing at the tee  $(0, 0)$  and hits the ball, where does the ball hit the ground on the hill?

First, equate the two equations:

$$x^2 + 12x = 0.8x$$

$$-x^2 + 11.2x = 0$$

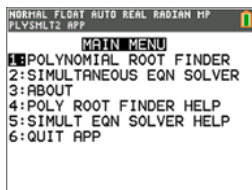
The roots of the resulting polynomial will give the intersection points of the ball path and the hill.

1. Press **apps** to display a list of applications on your calculator.
2. Select **PlySmlt2**.

The **ABOUT** screen displays.

3. Press any key to continue.

The **MAIN MENU** displays.



4. Select **POLYNOMIAL ROOT FINDER**.



## Example Activity – Simultaneous Equation Solver

Use this activity to learn the basics of the App.

A small corporation borrowed \$500,000 to expand its product line. Some of the money was borrowed at 9% interest, some at 10%, and some at 12%. How much was borrowed at each rate if the annual interest was \$52,000 and the amount borrowed at 10% was 2.5 times the amount borrowed at 9%?

Let  $x$  = amount of money borrowed at 9%

$y$  = amount of money borrowed at 10%

$z$  = amount of money borrowed at 12%

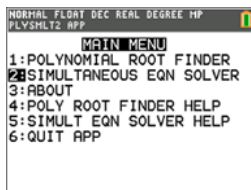
1. Write an equation for each of the statements:

$$x + y + z = 500,000$$

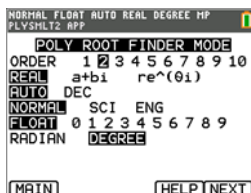
$$0.09x + 0.1y + 0.12z = 52,000$$

$$2.5x - y = 0$$

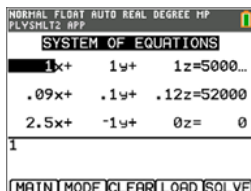
2. Press **[apps]** to display a list of applications on your calculator.
3. Select **PlySmt2**. The information screen displays.
4. Press any key to continue. The **MAIN MENU**




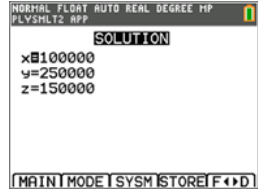
5. Select **Simultaneous Eqn Solver**.
6. Select 3 equations and 3 unknowns on the Simultaneous Equation Solver Mode screen. Press **NEXT** to continue.




7. Enter the coefficients for the variables and the constants in the equation. Press **[enter]** after each entry to move the cursor to the next position.



8. Select **SOLVE** (  ) to solve the system of equations. You see that the corporation borrowed \$100,000 at 9%, \$250,000 at 10%, and \$150,000 at 12%.



## Menus and Functions

- To display the MAIN MENU, select **Menu** ()
- To exit the application, select **Quit App** from the **MAIN MENU**.

Menus	Functions
<b>Main Menu</b>	
1: Polynomial Root Finder	Open the Polynomial Root Finder app.
2: Simultaneous Eqn Solver	Open the Simultaneous Equation Solver app.
3: About	Display the home screen with the version number.
4: Poly Root Finder Help	Help file for Polynomial Root Finder. Press <b>[2nd]</b> <b>[quit]</b> to return to the Main Menu.
5: Simult Eqn Solver Help	Help file for Simultaneous Equation Solver. Press <b>[2nd]</b> <b>[quit]</b> to return to the Main Menu.
6: Quit App	Closes the app and returns to the calculator home screen.
<b>Polynomial Root Finder Modes</b>	
Order	Set from 1 to 10.
Real / a+bi / re <sup>θi</sup>	Real mode does not display complex results. If you select this mode setting and the answer is complex, the result displays as NONREAL. a+bi (rectangular complex) mode displays complex numbers in the form a+bi. You may need to press <b>[&gt;]</b> to display all of the complex number. re <sup>θi</sup> (polar complex) mode displays complex numbers in the form of re <sup>θi</sup> . You may need to press <b>[&gt;]</b> to display all of the complex number.
Auto / Dec	AUTO displays answers in a similar format as the input. DEC displays answers as integers or decimal numbers.
Normal / Sci / Eng	Set the notation mode to Normal, Scientific, or Engineering.
Float	Floating decimal mode displays up to 10 digits, plus the sign and decimal.
Radian / Degree	Interpret angle values and display answers in radians or degrees.
Main	Display the main menu.
Help	Display the help screen.

Menus	Functions
Next	Go to the next screen – Polynomial coefficient entry.
Main	MAIN displays the main menu.
Mode	Return to the mode screen.
Clear	Clear all of the coefficient values that you have entered.
Load	Enter a list name that contains the coefficient values you want to use. You must set up the list in the list editor before you can use the list in the Polynomial Root Finder application. You cannot access the list editor while the application is running.
Solve	
Main	MAIN displays the main menu.
Mode	Return to the mode screen.
Coeff	Change the coefficient.
Store	Store the coefficients to a list, store polynomial to Y= or store roots to a list.
F $\leftrightarrow$ D	Convert values from fraction to decimal.
<b>Simultaneous Eqn Solver</b>	
Equations	Set the number of equations.
Unknowns	Set the number of unknowns.
Auto / Dec	AUTO displays answers in a similar format as the input. DEC displays answers as integers or decimal numbers.
Normal / Sci / Eng	Set the notation mode to Normal, Scientific, or Engineering.
Float	Floating decimal mode displays up to 10 digits, plus the sign and decimal.
Radian / Degree	Interpret angle values and display answers in radians or degrees.
Main	Display the main menu.
Help	Display the help screen.
Next	Go to the next screen – System of Equations.
Main	MAIN displays the main menu
Mode	Return to the mode screen.
Clear	Clear all of the matrix values that you have entered.
Load	Enter a matrix name that contains the matrix values you want to use. You must set up the matrix in the matrix editor before

Menus	Functions
	you can use the matrix in the app. You cannot access the matrix editor while the application is running.
Solve	Solve the system of equations. The entire solution may not fit on one screen. If an arrow displays on the left side of the screen, press $\square$ and $\square$ as necessary to view the entire solution. Each line of the matrix may not fit on the screen. Press $\square$ to scroll to the right to view the part of the line that is off the screen.
Main	MAIN displays the main menu.
Mode	Return to the mode screen.
Sysm	Display the system of equations screen so you can view or change the values.
Store	Store the system matrix or the solution matrix.
rref	Display the reduced row-echelon form of a matrix that has either no solution or infinite solutions.
Main	Display the main menu.
Back	Return to the solution set.
Sysm	Display the matrix entry screen so that you can view or change the values.
Store rref	Store the reduced row echelon form of a matrix to a matrix variable that you select.



# Using Probability Simulation App

Explore probability theory with animation that simulates the following:

- Toss coin
- Roll dice
- Pick marbles
- Spin spinner
- Draw cards
- Generate random numbers

Options include:

- Display of Data:
  - Bar Graph
  - Table of trials data
- Settings
  - Customize simulation
  - Number of trials
  - Weighting

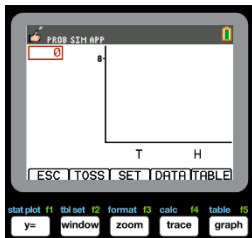
You can save simulation data to lists for further exploration.

## Example Activity – Toss Coins Simulation

**Tip:** Options display at the bottom of the screen to help you navigate and perform specific tasks.

To select one of these options, press the graphing key directly below it.

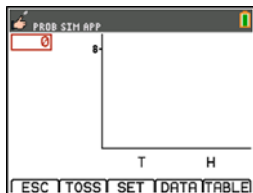
For example, to select [TBL], press **graph**.



1. Press **apps**.
2. Choose **Prob Sim**.
3. Choose **1: Toss Coins**.

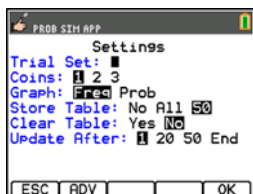


- Use the following key presses for this App:
  - ESC** to move to previous screen
  - TOSS** to toss one coin and access more tosses
  - SET** to get to the Settings screen (see below)
  - DATA** to store the collected data to a list
  - TABL** to show a table of the trials
  - GRPH** to show a graph of the trials

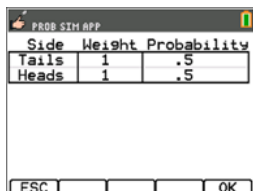


**Note:** You can toggle between the table and the graph.

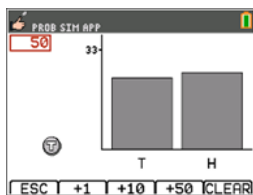
- Change these settings depending on what values are needed for the simulation. Press **ADV** from the **Settings** screen to change the weight of the coins.



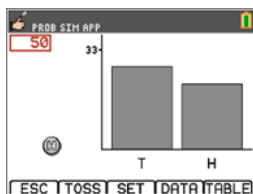
- Currently, the coins are equally weighted. Press **OK** when the settings and the weight for the simulation are appropriate. Next, press **TOSS**.



- One coin will toss. Now, press **+1**, **+10**, or **+50** depending on the data you wish to collect. The Frequency Graph updates with each coin toss. Press **<ESC>** when finished tossing the coins for this simulation.



- Next, press **ESC** and examine the table (**TABL**) or use **DATA** to store the data into lists.



9. Press **TABL** to see the value for each toss and the cumulative number of heads for the number of trials.

Toss	C1	CUMH
39	T	15
40	T	15
41	H	16
42	T	16
43	T	16
44	H	17
45	T	17
46	H	18
47	H	19
48	H	20
49	H	21
50	H	22

10. Press **DATA** to store the data in lists, which can be accessed later in the List Editor. The values of 0 for Tails and 1 for Heads are stored in list LC1.

Save Data To Lists  
 Toss Number: LTOSS  
 Coin 1 Data: LC1  
 Cumulative Heads: LCUMH

11. Next, quit the App by pressing **OK**, **<ESC**, **YES**, **QUIT**, **YES**. Make sure to save the data in lists (as shown above) so the simulation remains in memory when you turn the graphing calculator off.

## Menus and Functions

Each simulation has features appropriate for the type of simulation. The table below is a quick guide to see the features and options in each simulation.

- The main menu will appear when you open the App.
- Press **ESC** (press  $\boxed{y=}$ ) and **YES** (press  $\boxed{y=}$ ) to return to the main menu from a simulation.
- To exit the application, select **QUIT** (press  $\boxed{\text{graph}}$ ) from the main menu.

Menus	Functions
<b>Main Menu</b>	
Toss Coins	Creates a simulation of a two-sided coin toss, and you have the option to weight the sides of the coin. You can flip up to 3 coins at once, and the number of heads is tallied.
Roll Dice	Creates a simulation of rolling up to three dice. The type of dice includes 6, 8, 10, 12, and 20 sides. The sum of the faces is tallied.
Pick Marbles	Creates a simulation of picking up to 5 different marbles from a bag. The simulation can run with or without replacement. The number of each type of marble in each pick is tallied.
Spin Spinners	Creates a simulation of one spinner with between 2 and 8 sections. Each section can be weighted. The spinner results are tallied.
Draw Cards	Creates a simulation of drawing one card at a time from a 52-

Menus	Functions
	or 32-card deck. For each pick, the number and suit are tallied. The draw of a card from the deck can be set with or without replacement from each draw. You can only use one deck at a time.
Random Numbers	Generates (draws) a set of up to 6 random numbers. The number range can be set from 0 to 99. Repetition or no repetition of numbers from the range can be set as an option. Each draw of the random set is tallied on the screen.
OK	Open the selected simulation.
SEED	Set the random seed value.
ABOUT	App version number information.
QUIT	Exit the application.
<b>Toss Coins</b>	
ESC	Return to the previous screen
TOSS	Toss one coin and access more tosses.
SET (Settings)	Change the settings for the simulation.
Trial Set	Tosses coin(s) as per trial settings and allows shortcut option to toss +1, +10, or +50 more tosses to add on to the simulation. Enter trial value from 1 to 999 tosses.
Coins	Set the number of coins tossed per trial to 1, 2, or 3.
Graph	Set graph display to frequency or simulated probability. Use right and left arrows on the bar graph view to display these values.
StoTbl (Store Table)	Set to No, All, or 50 to control the trials displayed in the table view.
ClearTbl (Clear Table)	Set to Yes if you want to clear the data of an existing simulation.
Updates (Update After)	Number of trials before the graph and data are updated.
DATA	Save the collected data to a list.
TABLE	Show a table of the trials.
GRAPH	Show a graph of the trials.
<b>Roll Dice</b>	
ESC	Return to the previous screen
ROLL	Rolls a die or dice as per trial settings and allows shortcut

Menus	Functions
	option to toss +1, +10, or +50 more rolls to add on to the simulation.
SET (Settings)	Change the settings for the simulation.
Trial Set	Enter trial value from 1 to 999.
Dice	Set the number of die or dice tossed per trial to 1, 2, or 3.
Sides	Set number of sides to 6, 8, 10, 12, or 20.
Graph	Set graph display to frequency or simulated probability. Use right and left arrows on the bar graph view to display these values.
StoTbl (Store Table)	Set to No, All, or 50 to control the trials displayed in the table view.
ClearTbl (Clear Table)	Set to Yes if you want to clear the data of an existing simulation.
Updates (Update After)	Number of trials before the graph and data are updated.
DATA	Save the collected data to a list.
TABLE	Show a table of the trials.
GRAPH	Show a graph of the trials.
<b>Pick Marbles</b>	
ESC	Return to the previous screen
PICK	Pick number of marbles as per trial settings.
SET (Settings)	Change the settings for the simulation.
Trial Set	Enter trial value from 1 to 999.
Types	Set the number of different types of marbles in the simulation to 1, 2, or 3.
Graph	Set graph display to frequency or simulated probability. Use right and left arrows on the bar graph view to display these values.
StoTbl (Store Table)	Set to No, All, or 50 to control the trials displayed in the table view.
ClearTbl (Clear Table)	Set to Yes if you want to clear the data of an existing simulation.
Replace	Yes: Replaces the marble after it is drawn. No: The marble is removed when it is drawn.
Updates	Number of trials before the graph and data are updated.

Menus	Functions
(Update After)	
DATA	Save the collected data to a calculator list.
TABLE	Show a table of the trials.
GRAPH	Show a graph of the trials.
<b>Spin Spinner</b>	
ESC	Return to the previous screen.
SPIN	Spins the spinner as per trial settings and allows shortcut option to toss +1, + 10, or +50 more spins to add on to the simulation.
SET (Settings)	Change the settings for the simulation.
Trial Set	Enter trial value from 1 to 999.
Sections	Set the number of sections of the spinner from 2 to 8 sections.
Graph	Set graph display to frequency or simulated probability. Use right and left arrows on the bar graph view to display these values.
StoTbl (Store Table)	Set to No, All, or 50 to control the trials displayed in the table view.
ClearTbl (Clear Table)	Set to Yes if you want to clear the data.
Updates (Update After)	Number of trials before the graph and data are updated.
DATA	Save the collected data to a list.
TABLE	Show a table of the trials.
GRAPH	Show a graph of the trials.
<b>Draw Cards</b>	
ESC	Return to the previous screen
DRAW	Draw one card.
SET (Settings)	Change the settings for the simulation.
Decks	Set to 1, 2, or 3 decks.
Replace	Yes: Replaces the card after it is drawn. No: The card is removed when it is drawn.
Deck Size	Set the card deck size to 52 or 32 cards.
DATA	Save the collected data to a list.

Menus	Functions
CLEAR	Clear all trials from memory.
<b>Random Number Sets</b>	
ESC	Return to the previous screen.
Draw	Roll one dice.
SET (Settings)	Change the settings for the simulation.
Numbers	Set between 1 and 6 random numbers per draw.
Range	Enter the range of numbers from 0 to 99.
Repete	Yes: Reuse numbers after they have been chosen. No: each trial will be unique.
DATA	Save the collected data to a list.
CLEAR	Clear all trials from memory.
<b>Advanced Options Menu</b>	
ADV (Advanced)	Set weight or probabilities for Toss Coin, Roll Dice, or Spin Spinner outcomes. Set the amount of each different marble in the simulation for Pick Marbles.

## **Error Messages**

Error Message	Description
There is no data to export. Memory Error	No simulations were stored.
There is not enough memory to export data. Maximum Trials Reached	Leave the App and delete memory to create room to store your simulations.
Not enough memory to store more individual trials.	Leave the App and delete memory to create room to store your simulations.

# Using Science Tools App

Science Tools App allows you to perform unit conversions on your calculator. App elements include:

- Significant Figures Calculator
- Constants and Conversions

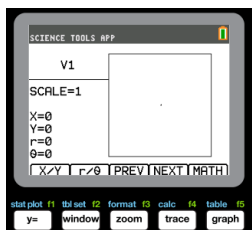
**Note:** The values of constants in the Unit Converter tool are the latest values recommended by the Committee on Data for Science and Technology (CODATA) and the National Institute of Standards and Technology (NIST). For more information, check the NIST web site at <http://physics.nist.gov/>.

- Data and Graph Wizard
- Vector Calculator

## Example Activity – Science Tool

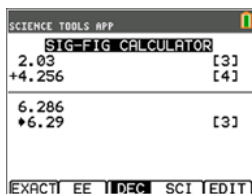
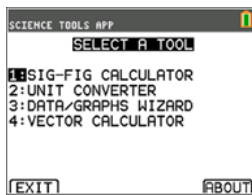
**Tip:** Options display at the bottom of the screen to help you navigate and perform specific tasks. To select one of these options, press the graphing key directly below it.

For example, to select [X,Y], press  $\boxed{f(x)}$ .



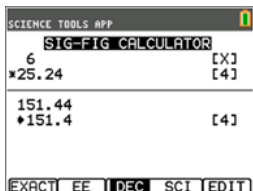
## Exploring the Significant Figures Calculator

1. To begin:
  - a) Press  $\boxed{\text{apps}}$ .
  - b) Use the  $\boxed{4}$ ,  $\boxed{\rightarrow}$ ,  $\boxed{\uparrow}$ ,  $\boxed{\downarrow}$  keys to highlight and choose SciTools.
  - c) Press [enter].
  - d) Press any key to enter the Science Tools App.
2. Choose **1:SIG-FIG CALCULATOR**.
3. Key in **2.03 + 4.256** and press [enter]. Notice how the environment takes into account the number of significant digits when performing computations.



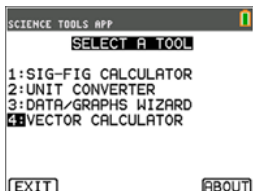


4. Press [enter] to clear the screen.
5. Key in 6.0 and press [EXACT] ( $\overline{y=}$ ).  
**Note:** This marks 6.0 as an exact value and will not affect the number of significant figures in the final result.
6. Press  $\times$  and input **25.24**.
7. Press [enter].



### Exploring the Vector Calculator

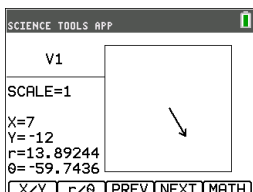
1. To begin:
  - a) Press  $\overline{\text{apps}}$ .
  - b) Use the  $\overline{4}$ ,  $\overline{\rightarrow}$ ,  $\overline{\uparrow}$ ,  $\overline{\downarrow}$  keys to highlight and choose SciTools.
  - c) Press [enter].
  - d) Press any key to enter the Science Tools App.
2. Choose **4:Vector CALCULATOR**.



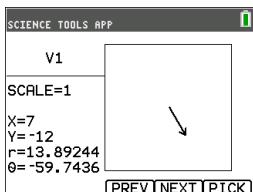
### To draw a vector graphically:

- a) Press  $\overline{X/Y}$  ( $\overline{y=}$ ) to input a vector's coordinates.
- b) Key in **7** for the X-value.
- c) Key in **-12** for the Y-value.
- d) Press  $\overline{\text{graph}}$ .

Note: The App computes "r" and " $\theta$ " values .

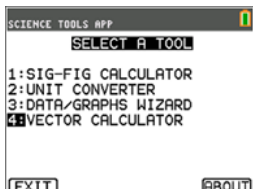


3. Press [MATH] ( $\overline{\text{graph}}$ ).
4. Choose **V1** (the first vector) by pressing the [PICK] ( $\overline{\text{graph}}$ ) button.
5. Choose **[+]** ( $\overline{y=}$ ) and then press [NEXT] ( $\overline{\text{trace}}$ ) to find the second vector. Once found, press [PICK]. Notice how the resultant vector is computed and drawn.

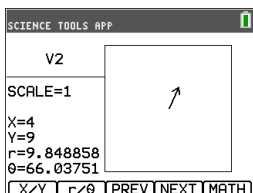


### Exploring the Vector Calculator

- Continuing from the previous example, press **[2nd]** **[quit]** to return to the SELECT A TOOL screen.
- Choose **4:VECTOR CALCULATOR**.
- Draw 2 Vectors:**

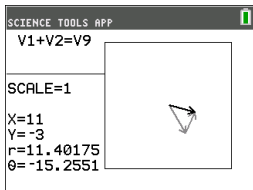
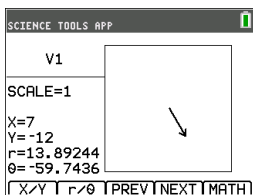


- Press **[X/Y]** to input V1 coordinates.
- Enter **7** for the X-value and press **[enter]**.
- Enter **-12** for the Y-value and press **[enter]**.
- Press **[VIEW]**.  
**Note:** The App computes "r" and "θ" values .
- Press **[NEXT]** to enter V2 coordinates.
- Press **[X/Y]**.
- Enter **4** for the X-value and press **[enter]**.
- Enter **9** for the Y-value and press **[enter]**.



#### 4. Vector Calculations:


- Press **[MATH]**.  
**Note:** This is the **[MATH]** shortcut key at the bottom of the screen and not the **[math]** key on the graphing calculator. In this case, press the **[graph]** key to get **[MATH]**.
- Choose **V1** (the first vector) by selecting **[PICK]**.
- Choose **[+]** and then press **[NEXT]** to find the second vector.
- Once found, press **[PICK]**.  
Notice how the resultant vector is computed and drawn.



## Menus and Functions

- Use **[2nd]** **[quit]** to return to the Main Menu from the science tools.

Menus	Functions
<b>Main Menu</b>	
1: Sig-Fig Calculator	Display the significant digits and figures calculator tool.
2: Unit Converter	Display the unit converter tool.
3: Data/Graphs Wizard	Display the data/graphs wizard.

Menus	Functions
4: Vector Calculator	Display the vector calculator.
Exit	Exit the application.
About	App version number information.
<b>Sig-Fig Calculator Menu</b>	
Exact	Set a value as “exact” so that it will not be subject to rounding.
EE	Enter a value in scientific notation.
Dec / Sci	Specify whether results are displayed in decimal notation (DEC) or scientific notation (SCI).
Edit	Edit the previous calculation.
<b>Unit Converter Menu</b>	
Constant	Displays the <b>CONSTANTS</b> menu.
Convert	Returns to the <b>UNIT CONVERTER</b> menu.
Expt	Pastes (exports) the constant to the home screen. You must exit the application to view the home screen.
Edit	Copies the constant to a conversion screen. If the constant corresponds to a conversion category, the category is automatically selected. If it does not correspond to a conversion category, the <b>UNIT CONVERTER</b> menu is displayed. After you select a conversion category, the constant is pasted into the conversion screen.
Copy	Display the <b>UNIT CONVERTER</b> menu. After you select another conversion category, the converted value is pasted into the conversions screens.
Edit	Allows you to edit the converted value.
<b>Data/Graphs Wizard Menu</b>	
Data	Enter or edit data in lists
Plot 	Plot data.
Stat	Analyze data.
<b>Vector Calculator Menu</b>	
X/Y	Enter x and y coordinates for the head of the vector.
r/θ	Enter r and θ coordinates for the head of the vector.

Menus	Functions
Prev	Display the previous screen.
Next	Display the next vector screen.
Math	Display the vector math operators at the bottom of the screen (+, -, •, x) .
View	Display all of the values for the vector (x, y, r, and $\theta$ ) .
Pick	Select the current vector for a vector math operation.

## **Error Messages**

Error Message	Description
Arithmetic Error	This is a general error caused by a limitation error (such as an overflow error when a result is $\geq 1E100$ ) or a mathematical error (such as divide-by-zero).
Err: Memory	This error occurs when the graphing calculator does not have enough free RAM to perform the operation. Also, if the unit has less than XXXX bytes, the application will not start.
Fit Error	This error occurs when a regression fit cannot be performed on a scatterplot or xyline plot, because the data in the lists is not compatible with that type of regression. The error also occurs if you press <b>on</b> to break (stop) a regression fit calculation in progress.
Input Error	This error occurs when an invalid entry is entered into an editor field. For example, an error occurs if you enter 1..2 instead of 1.2.
Stat Error	This error occurs if you select STAT to perform a one-variable statistical calculation on a list containing data that is incompatible with one-variable analysis.

# Using Transformation Graphing App

Transformation Graphing App enhances the  $\boxed{y=}$  function mode and lets you observe the effects of changing coefficient values without leaving the graph screen. The transformation feature is only available in function mode ( $\boxed{\text{mode}}$ ).

Transformation Graphing allows you to manipulate up to four coefficients on the graph: A, B, C, and D. All other coefficients act like constants, using the value in memory. You step through the transformation of a function or animate the transformation using play styles, play/pause, play and fast play. You can enter functions directly or use the color/line style spinner dialog to paste functions such as:

$$AX + B$$

$$AX^2 + B$$

$$A(X-B)^2 + C$$

$$A(X-B)(X-C)$$

$$AX^2 + BX + C$$

$$A(X-B)^3 + C$$

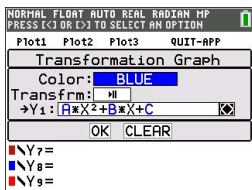
$$AX^3 + BX^2 + CX + D$$

$$A \text{ abs}(B(X-C)) + D$$

$$A \sin(B(X-C)) + D$$

$$A \cos(B(X-C)) + D$$

$$A \tan(B(X-C)) + D$$



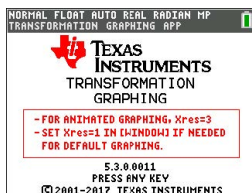
## Example Activity

### Explore the Function $Y=AX^2+BX+C$

Use this activity to learn the basics the Transformation Graphing App.

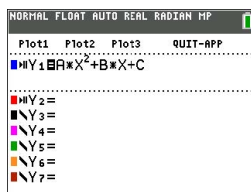
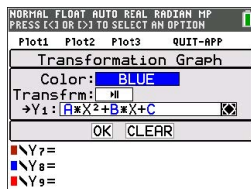
**Note:** Reset the calculator defaults ( $\boxed{2nd}$   $\boxed{\text{mem}}$   $\boxed{7}$ :Reset...,  $\boxed{2}$ :Defaults...,  $\boxed{2}$ :Reset) before this performing this activity.

1. Press  $\boxed{\text{apps}}$ .
2. Choose **Transfrm.**
3. Read the message on the splash screen.
4. Press any key to dismiss the splash screen.



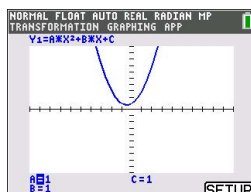
- In Func mode, press  $\boxed{Y=}$  to display the Y= editor.
- Press  $\boxed{\text{clear}}$  to clear Y1.
- To quickly paste the function  $Y_1=AX^2+BX+C$ , press  $\boxed{\leftarrow} \boxed{\leftarrow} \boxed{\text{enter}}$  to launch the line style spinner.
- Press  $\boxed{\downarrow} \boxed{\downarrow}$  and then  $\boxed{\rightarrow}$  to the desired function.
- Select OK and press  $\boxed{\text{enter}}$ .

**Note:** The color/line style spinner dialog also lets you select the animation of the transform graph. Play-Pause  $\gg \text{II}$  will allow you to control the animation of the graph using the arrow keys on the graph screen.



**Tip:** If you enter a function using the keypad, only A-D are allowed in transform equations Y1 and/or Y2. Those letters can be found using the  $\boxed{\alpha}$  key. For example, to enter the coefficient A, press  $\boxed{\alpha} \boxed{A}$  (above the  $\boxed{\text{math}}$  key).

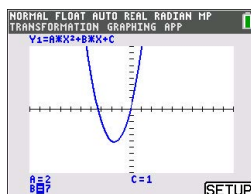
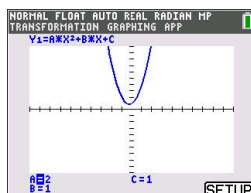
- Press  $\boxed{\text{zoom}} \boxed{6}$  to select **6:ZStandard**. The graph screen displays automatically. The selected Y= function and the current values of the coefficients A, B, and C display on the screen. The values of A, B, and C may be different on your calculator.



- Press  $\boxed{\rightarrow}$  to increment the value of A by the Step value (1) from 1 to 2. The graph is redrawn automatically, showing the effect of increasing the coefficient of X by step size 1 as set in the SETTINGS ([SETUP]) menu.

If the coefficient A is not selected, press  $\boxed{\downarrow}$  until the = sign for A is highlighted.

- Press  $\boxed{\downarrow}$  to highlight the = sign for B. Press  $\boxed{\rightarrow}$  several times (pausing briefly each time as the graph is redrawn) to observe the effect of increasing the value of B.



**Tip:** Press [SETUP] ([f5]) on the graph screen to display the SETTINGS menu.

Select TrailOn to leave a dotted graph each time you change or animate a coefficient. Default is TrailOff. TrailOff and TrailOn are also available in [2nd] [format].

The play > and play fast >> settings allow you to create animated slide show of the graph transforming by one selected parameter. The parameter values for A-D can be entered in SETTINGS as long as they are used in Y1 and/or Y2.



The Step value determines the increment of the parameter value. The Max value is the upper bound of the parameter expected in the animation.

Example:  $Y1=AX$

In SETTINGS, let  $A=1$ , Step = 2, and Max = 10. Five screens will be created to animate the graph for  $A = 1, 3, 5, 7, 9$ . Note  $9 < 10 = \text{Max}$ .

There can be up to 13 screens created for the animation. A memory error will be given if the Step and Max request more than 13 screens for the animation. To continue, press [window] and press [↵] to SETTINGS. Modify the Step or Max value to remain within the 13 screen limit.

**Note:** Enter a quadratic function in vertex form to graph in Y3. Try to match Y1 to the graph of Y3!

## Menus and Functions

- To quit the App, select the QUIT-APP option at the upper-right of the Y=screen. Select **2:Quit Transfrm** at the prompt.
- Inequality Graphing App and Transformation Graphing App cannot run at the same time since they enhance the Function Mode of the [y=] editor. If the Apps are in conflict, follow the prompts to quit the conflicting App, which will allow the other App to run as an enhanced [y=] editor.
- The Transformation Graphing App is best used for animation graphing investigations. The window variable Xres is set to 3 when the app launches. This plots every third graphing pixel and provides the best experience when using animations for Y1 and/or Y2. While Xres can be set to 1 in [window], your general graphing experience without animations will be optimal in the standard graphing mode where Xres defaults to 1.

Menus	Description
<b>Graph/Plot Setup Keys</b>	
[y=]	Displays the [y=] Editor, where you can: <ul style="list-style-type: none"> <li>enter one or more functions</li> </ul>

Menus	Description
	<ul style="list-style-type: none"> <li>animate functions in Y1 and/or Y2</li> <li>graph functions using Y3-Y0</li> <li>graph up to three plots</li> <li>change the graph color</li> <li>change the transformation play type</li> <li>select a function format to paste for Y1 and/or Y2</li> <li>change the color and line style of Y3-Y0</li> </ul> <p>Press <math>\leftarrow</math> until the cursor is over the style column at the left of the Yn function. Press [enter]. Navigate to the options using <math>\downarrow</math>. Press <math>\leftarrow</math> or <math>\rightarrow</math> on a spinner menu to make a selection. Select <b>OK</b> or <b>CLEAR</b> to accept or dismiss the changes.</p>
Play-Pause (>  )	Controls which coefficient is changed and when the graph is plotted.
Play (>)	Stores a series of changes as pictures to display in a slide show format. The pictures play in a continuous loop until you stop them. Use [enter] and then $\boxed{\text{on}}$ to stop animations. *See Note following the table.
Play Fast (>>)	Stores a series of changes as pictures to display in a slide show format. The pictures play in a continuous loop until you stop them. It displays the pictures at a more rapid rate than Play. Use [enter] and then $\boxed{\text{on}}$ to stop animations. *See Note following the table.
$\boxed{\text{window}}$	Set the viewing window to produce the best display of your graph.
$\boxed{\text{zoom}}$	Quickly adjust the window to a pre-defined setting.
$\boxed{\text{trace}}$	Move the cursor along the graphed function using $\leftarrow$ and $\rightarrow$ .
$\boxed{\text{graph}}$	Display the graph you have defined.
[SETUP]	On the graph screen, pressing [SETUP] ( $\boxed{\text{graph}}$ ) will display the SETTINGS menu where you can select animation play types, TrailOff/TrailOn setting, and set the values of the parameters A, B, C, or D (if entered in Y1 and/or Y2). Press $\boxed{\text{graph}}$ on the SETTINGS screen to display the graph.
TrailOff TrailOn	In $\boxed{2\text{nd}}$ [format], TrailOn leaves a dotted graph style of each graph as the coefficient is changed or animated. Default is TrailOff.

**\*Note:** A memory error occurs if there are more than 13 screens to create for the animation. Press  $\boxed{\text{window}}$  and  $\uparrow$  to SETTINGS. Change the parameter start value, the step and/or the Max so the sequence of screens requested remains at most 13.

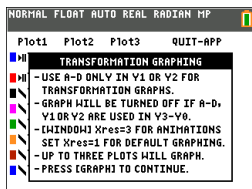


## Transformation Graphing Rules

The following rules are applied when using the Transformation Graphing App:

- Allows Y1 and/or Y2 to transform using parameters A, B, C, or D in the functions. Graphing using Y3-Y0 is allowed, however, A-D, Y1 and Y2 are not allowed in Y3-Y0.
- **window** setting Xres=3 is set for animations. Set Xres=1 in [window] for default graphing if needed when only graphing in Y3-Y0.
- Up to three stat plots can be graphed.
- Recommend using QUIT-APP in [Y=] when not transforming graphs.

If any of these rules are broken, the following message will appear and the offending Y-Vars are disabled and the remaining graphs will appear.



## General Information

### ***Online Help***

[education.ti.com/eguide](http://education.ti.com/eguide)

Select your country for more product information.

### ***Contact TI Support***

[education.ti.com/ti-cares](http://education.ti.com/ti-cares)

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### ***Service and Warranty Information***

[education.ti.com/warranty](http://education.ti.com/warranty)

Select your country for information about the length and terms of the warranty or about product service.

Limited Warranty. This warranty does not affect your statutory rights.