TI-83 Plus Conic Graphing

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Where to Find Installation Instructions

You can find detailed instructions on installing this and other free Flash applications in the guides section of education.ti.com. Follow the link to Flash Installation Instructions.

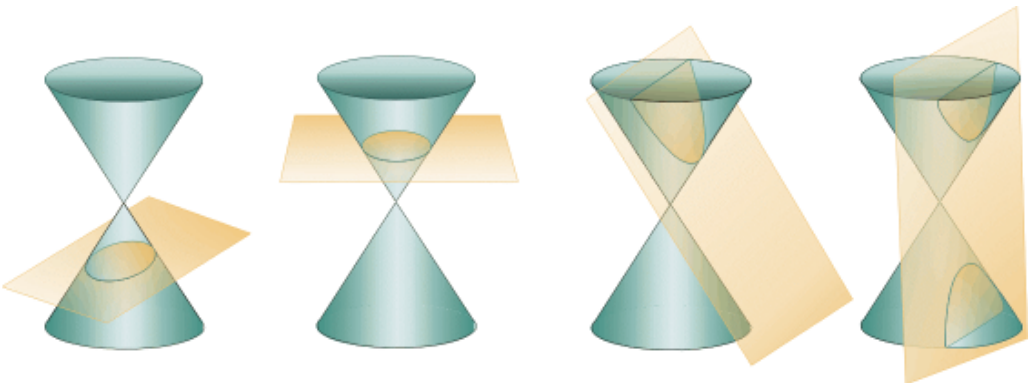
Installing this application requires TI-GRAPH LINK™ software and link cable. You can purchase a link cable from the online store. After you enter the store, follow the links to Computer Software, then TI-GRAPH LINK.

You can download a free copy of the latest version of TI-GRAPH LINK software from the software section of education.ti.com. Follow the links to Connectivity Software, then TI-GRAPH LINK.

What is Conic Graphing?

Conic Graphing is a TI‑83 Plus calculator software application that you can use to graph the four basic conic sections. The conic equations can be in function, parametric, and polar forms.

Conic Graphing does not address degenerate cases of conic sections where the plane passes through the vertex resulting in a point, line, or two intersecting lines.



Ellipse Circle Parabola Hyperbola

Starting and Quitting Conic Graphing

Starting Conic Graphing	Quitting Conic Graphing
1. Press [APPS] to display the list of applications on your calculator. 2. Press [▲] or [▼] to move the cursor to **Conics** and press [ENTER]. The CONICS main menu is displayed.	From the CONICS main menu: Select **QUIT**. From any other screen: Press [2nd] [QUIT]. 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 be displayed.

Getting Started

Work through this exercise to become familiar with the basic features of the Conic Graphing application. In this exercise, you trace the trajectory of Haley's comet.

One of the more common uses of conics is to show the orbits of planets and other astronomical bodies. Planets have closed orbits that are almost circular, while comets have highly elliptical orbits. For example, Haley's comet follows a long path out from the sun, but passes very close to the sun when it returns to the solar system. It has a major axis of 36.18 astronomical units, and an eccentricity of 0.97 (Larsen, Hostetler, and Edwards. 1997, 821). You can use Conic Graphing to trace the trajectory of Haley's comet.

Note

To complete this exercise, you need to set your calculator to radian mode before you start the Conics application. To do this:

1. Press [MODE].
2. Move the cursor to Radian, and press [ENTER].
3. Press [CLEAR] to exit the mode screen.

1. We know the following: $r = \frac{2ep}{1+e \sin \theta}$, e = 0.97, and

   $2a \approx 36.18$. Find p, the halfway point of the distance from the focus to the directrix.

   $r_1 = \frac{2ep}{1+e\sin\frac{\pi}{2}}$ $r_2 = \frac{2ep}{1+e\sin\frac{3\pi}{2}}$

   $2a \approx 36.18 \approx r_1 + r_2$, then

   $36.18 \approx \frac{2ep}{1+e\sin\frac{\pi}{2}} + \frac{2ep}{1+e\sin\frac{3\pi}{2}}$

   Thus, p = .551

2. Select **ELLIPSE** from the CONICS main menu.

3. Press [MODE] to display the CONIC SETTINGS screen.

4. Select **POL** to change the mode to polar.

5. Select **Man** so that you can manually change window settings.

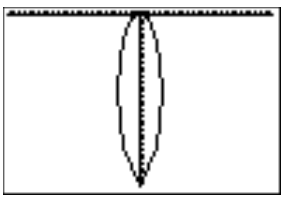
6. Select **ESC** to return to the ELLIPSE screen.

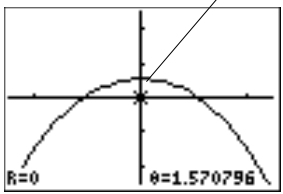
7. Press [▼] to select equation 4, $R = \frac{2ep}{1 + e \sin(\theta)}$.

8. Enter these parameters for e and p, as defined above in step 1: e = 0.97, p = .551

9. Press [ZOOM] to display the CONIC ZOOM screen.

10. Select **Zoom Conic** so that the aspect ratio on the screen is square. The graph of the ellipse is drawn.





The center $(0, \frac{\pi}{2})$ is the sun. The graph shows the path around the sun.

To see this graph, press [ZOOM], and select ZStandard, then press [ZOOM], and select ZoomIn. Press [ENTER] with the cursor near the origin.

11. Press [Y=] to exit the graph screen.

12. Press [ALPHA] [SOLVE] to find the foci. One focus is the sun at distance 0, angle $\frac{\pi}{2}$, ≈ 1.5708 radians. (If the calculator is in degree mode, the distance is 0 and the angle is 90 degrees. To change to degree mode, you must exit Conic Graphing.)

13. Press [TRACE] to trace the trajectory.

Note Conic Graphing does not allow for continuous tracing. For example, after you trace the entire ellipse, the tracing stops. You can then press the opposite direction arrow to trace the object in the opposite direction.

Variables Used or Modified by the Application

Conic Graphing modifies various calculator and window variables.

- Y-vars in the list below are modified, but are not restored when you exit the application.
- Real number variables in the list below are modified, but are restored after you exit the application.
- If any of the variables were archived, Conic Graphing unarchives them, but does not archive them again after you exit the application.

Variable type	Variables used or modified
Y-vars	Parametric equation editor: X1T, Y1T, X2T, Y2T
	Polar equation editor: r1
Real number variables	A, B, C, D, E, F, G, H, J, K, L, M, N, O, P, Q, R, S, T, U, W, X, Y, Z, θ

See the TI-83 Plus manual Getting Started section for more information about variables.

Conic Settings

You can graph conic sections in function, parametric, or polar mode, based on your requirements. The Conic Graphing application restores the calculator to the original mode (before you started the application) when you exit the application.

Graphing Mode	Description
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 θ

You can also select automatic or manual window settings.

- Automatic changes the viewing window settings so that the conic section is displayed, no matter where it is on the graph. You cannot access window or zoom settings to change them manually.
- Manual allows you to change the window and zoom settings manually. If the conic section is graphed outside of the viewing window, you must manually change the settings so that it will be displayed in the viewing window.

From any Conic Graphing screen:

1. Press [MODE]. The CONIC SETTINGS screen is displayed.

2. Press [▶] or [◀] to highlight a graphing type mode and press [ENTER] to select it.

3. Press [▼] to move to WINDOW SETTINGS.

4. Press [▶] or [◀] to highlight **AUTO** (automatic) or **MAN** (manual) and press [ENTER] to select it.

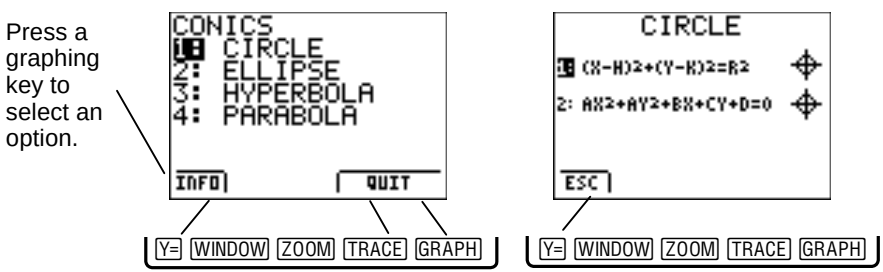
5. Press [Y=] to select **ESC** to save the settings and return to the previous screen.

Conic Graphing Options

Selecting Options

To select an option at the bottom of a Conic Graphing screen, press the graphing key directly below the option.

- Select **INFO** to display the information screen, which contains the application version number.
- Select **QUIT** to exit Conic Graphing.
- Select **ESC** to go back one screen.



Window and Zoom Settings

CONIC WINDOW

The CONIC WINDOW settings screen allows you to modify the window characteristics. This screen is similar to the calculator's window settings screen. You can change individual window parameters as needed.

1. Make sure that the conic graphing type mode is set correctly (to function, parametric, or polar, depending on what the equation requires).

2. Make sure the window settings mode is set to **MAN**.

3. Select a conic section from the CONICS main menu: **CIRCLE**, **ELLIPSE**, **HYPERBOLA**, or **PARABOLA**.

4. Select an equation.

Note

- You can only access the CONIC WINDOW screen after you have selected an equation to graph.
- You can only access the CONIC WINDOW screen if the mode is set to MAN.

5. Set the parameters (for example, provide H, K, and R for the first circle equation in function mode).

6. Press WINDOW.

7. Change the window parameters as needed.

8. Press Y= to return to the previous screen.

Graphing Mode	Window Parameter	Description
All modes	Xmin	Smallest x value to be displayed in the viewing window
	Xmax	Largest x value to be displayed in the viewing window
	Xscl	Spacing between the tick marks on the x-axis
	Ymin	Smallest y value to be displayed in the viewing window
	Ymax	Largest y value to be displayed in the viewing window
	Yscl	Spacing between the tick marks on the y-axis
Parametric mode	Tmin	Smallest T value (step) to evaluate

Graphing Mode	Window Parameter	Description
	Tmax	Largest T value to evaluate
	Tstep	Step increment
Polar mode (ellipse equations and circle equations 1 and 2)	θmin	Smallest θ value (angle) to evaluate in radians/degrees
	θmax	Largest θ value to evaluate in radians/degrees
	θstep	θ increment in radians/degrees

Conic Graphing allows you to graph a partial conic section. To do this, you must modify Tmin, Tmax, or Tstep (in parametric mode) or θmin, θmax, or θstep (in polar mode, for the ellipse and circle equations 1 and 2 only).

CONIC ZOOM

The CONIC ZOOM settings screen allows you to adjust the viewing window of the graph quickly. This screen is similar to the calculator's zoom settings screen. Zoom settings that do not apply to conic sections are not displayed.

Zoom Conic is a new zoom setting that applies only to Conic Graphing. It changes the viewing window so that you can see the important characteristics of the conic section, regardless of the conic section's position on the graph. The following table describes how Conic Graphing changes the calculator default variables, based on the zoom setting you choose.

Note

- You can only access the CONIC ZOOM screen after you have selected an equation to graph.
- You can only access the CONIC ZOOM screen if the mode is set to MAN.

Zoom Parameter	Description
Zoom Conic	Changes the zoom parameters so that you can see the important characteristics of the conic section in the viewing window, regardless of conic section's position on the graph. Also, changes the viewing window so that $\Delta X=\Delta Y$, which makes the graph of a circle look like a circle. (Otherwise, it would look like an ellipse.)
Zoom In	Magnifies the graph around the cursor.
Zoom Out	Views more of the graph around the cursor.
ZBox	Draws a box to define the viewing window.
ZSquare	Changes the viewing window based on the current window variables so that $\Delta X=\Delta Y$, which makes the graph of a circle look like a circle. (Otherwise, it would look like an ellipse.) The midpoint of the current graph (not the intersection of the axes) becomes the midpoint of the new graph.
ZStandard	Sets the standard window variables: Xmin = −10, Xmax = 10, Ymin = −10, Ymax = 10.

To see how different zoom settings affect the graph:

1. Make sure that the conic mode is set correctly (to function, parametric, or polar, depending on what the equation requires).
2. Select a conic section from the CONICS main menu.
3. Select an equation.
4. Enter values for each of the required parameters listed. Use ▲ and ▼ to move from one parameter to the next.

Tip If you enter a value that is invalid for the specific equation, an error screen displays when you attempt to graph the conic section.

5. Press ZOOM.
6. Select **Zoom Conic** and view the graph.
7. Press ZOOM.
8. Select other zoom settings to see the differences in the graph. The graph is displayed after a zoom setting is selected (except for zoom settings that require another entry, such as Zoom In or Zoom Out).

Graphing a Conic Section

When you graph a conic section, you select an equation and input values for the parameters. For example, if you select the circle equation $(X-H)^2 + (Y-K)^2 = R^2$, you input values for H, K, and R.

Keep the following points in mind when you input the parameters:

- Conic Graphing only supports real numbers; complex numbers are not supported.
- You can input a value with an unlimited number of digits, but Conic Graphing displays a rounded number to 14 digits.
- Conic Graphing works with 12-digit accuracy for all computations performed.

When you enter parameters, you can access the MATH (MATH), TEST (2nd [TEST]) and VARS (VARS) menus. (For example, you might want to use the cube root or absolute value options from the MATH menu or test a value using an option from the TEST menu.) However, when you display either of these menus, both the graphing keys and their secondary functions are ignored. Menu options that are not applicable to Conic Graphing are also ignored. To return to Conic Graphing from these menus, press CLEAR.

Caution If you press 2nd [QUIT] to exit the MATH, TEST, or VARS menu, you will exit the Conic Graphing application.

To graph a conic section:

1. Make sure the conic mode is set appropriately for your equation.
2. Select a conic section from the CONICS main menu.
3. Select an equation for the conic section.

Tip A conic section may have more than one equation option for each mode. If an arrow appears below the equation number, you can press ▼ to see more equations.

4. Enter values for each of the required parameters listed. Press [ENTER] to move the cursor to the next parameter. You can also press [▲] and [▼] to move from one parameter to the next.

Note The number and type of required parameters change, depending on the equation you select and on the conic mode setting. If you enter an invalid value, an error message is displayed.

5. Press [GRAPH] to graph the conic section.

Note Plot selections (Plot1, Plot2, Plot3) are disabled in Conic Graphing.

6. Press [Y=] to escape from the graph screen. (The ESC option is not displayed on the graph screen, but is still available.)

Tracing a Conic Section

1. Press [TRACE]. A cursor appears on the conic section.
2. Press [◄] or [►] to trace along the conic section.

Note

- Press [▲] or [▼] to move from one part of a hyperbola to the other.
- Conic Graphing does not allow for continuous tracing. For example, after you trace an entire circle, the tracing stops. You can then press the opposite direction arrow to trace the object in the opposite direction.

Using Free Trace

Conic Graphing does not have a free trace feature. However, you can use a zoom option to simulate a free trace.

1. Graph a conic section.
2. Press [ZOOM].
3. Select **Zoom In**, **Zoom Out**, or **Zbox**.
   A free cursor is on the screen.

4. Use [◀], [▲], [▶], [▼] to move the cursor around on the screen.

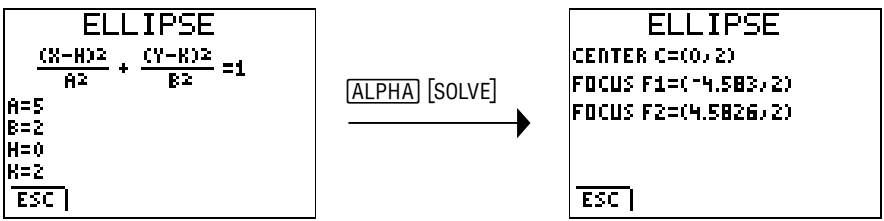
5. Press [Y=] to escape from the graph.

Note

Zoom In, **Zoom Out**, or **Zbox** options place a free cursor on the screen because each is waiting for you to position the cursor and press [ENTER] so that the zoom can be carried out. Do not press [ENTER] unless you want to carry out that zoom feature.
Press [GRAPH] to clear the cursor and coordinates from the screen without exiting the graph.

Finding Characteristics of Conic Sections

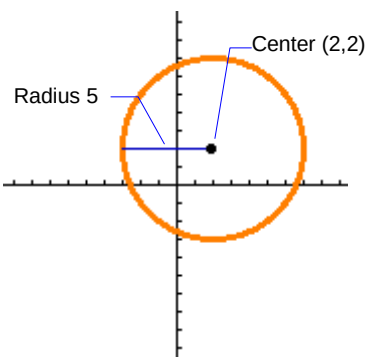
After you enter the values for each of the required variables, you can display information for the conic equation. Press [ALPHA] [SOLVE] to display the solution.



Note You can only press [ALPHA] [SOLVE] to display the solution from the equation screen.

Graphing Examples

Circles

Definition	Calculator mode	Equations
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.	Function	$(X-H)^2 + (Y-K)^2 = R^2$ $AX^2 + AY^2 + BX + CY + D = 0$
$(X-2)^2 + (Y-2)^2 = 25$: 	Parametric	$X = R \cos(T) + H$ $Y = R \sin(T) + K$
	Polar	$R = 2A \cos(\theta)$ $R = 2A \sin(\theta)$ $A^2 = B^2 + R^2 - 2BR \cos(\theta - b)$

Example

Graph an arc of a circle with radius = 8 whose center is at (0,0), using parametric mode.

Note

To complete this exercise, you need to set your calculator to radian mode before you start the Conic Graphing application. To do this:

1. Press MODE.
2. Move the cursor to Radian, and press ENTER.
3. Press CLEAR to exit the mode screen.

Steps:

1. Start the Conic Graphing application.
2. Select **CIRCLE** from the CONICS main menu.
3. Press MODE to display the CONIC SETTINGS screen.
4. Select **PAR** to change the mode to parametric.
5. Select **MAN** so that you can manually change window settings.

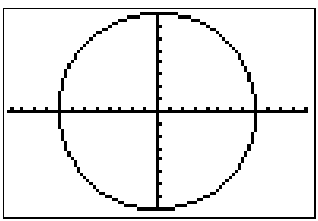
6. Select **ESC** to return to the CIRCLE screen.

7. Select the equation **X = R cos (T) + H**
   Y = R sin (T) + K

8. Enter the values for H, K, and R [(0,0) and 8], as defined in the problem.

9. Press [ZOOM] to display the CONIC ZOOM screen.

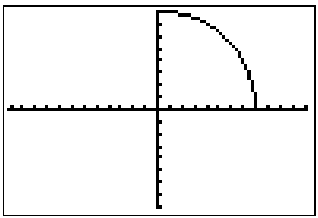
10. Select **Zoom Conic** so that the circle will be displayed correctly. (Otherwise, the circle may look like an ellipse.) The graph of the circle is drawn.



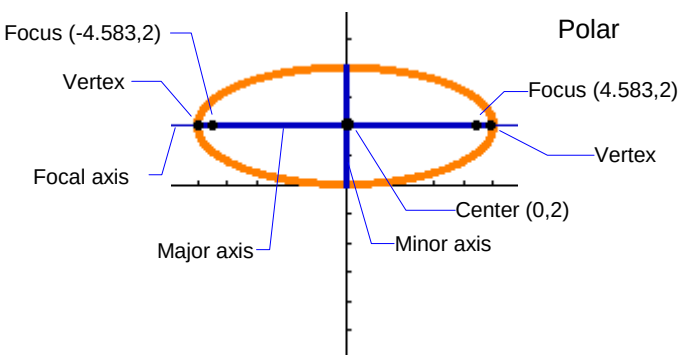
11. Press [WINDOW] to change the CONIC WINDOW settings.

12. Change the following parameters:
    Tmin = 0
    Tmax = $\frac{\pi}{2}$ (In degree mode, Tmax = 90. To change to degree mode, you must exit Conic Graphing.)

13. Press GRAPH to graph the arc.
    You can change the **Tmin** and **Tmax** values to display the graph of the arcs in different quadrants.



Ellipses

Definition	Calculator mode	Equations
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.	Function	$\frac{(X-H)^2}{A^2} + \frac{(Y-K)^2}{B^2} = 1$ $\frac{(X-H)^2}{B^2} + \frac{(Y-K)^2}{A^2} = 1$
	Parametric	X = A cos (T) + H Y = B sin (T) + K X = B cos (T) + H Y = A sin (T) + K
$\frac{X^2}{25} + \frac{(Y-2)^2}{4} = 1$: 	Polar	$R = \frac{2ep}{1-e\cos(\theta)}$ $R = \frac{2ep}{1+e\cos(\theta)}$ $R = \frac{2ep}{1-e\sin(\theta)}$ $R = \frac{2ep}{1+e\sin(\theta)}$

Example

The planet Pluto moves in an elliptical orbit with the sun at one of the foci. Pluto's orbit has an aphelion (distance farthest from the sun) of 7304.33×10^6 km and a perihelion (distance nearest to the sun) of 4434.99×10^6 km (NASA Goddard. 2001). Graph the shape using the polar form.

Note

To complete this exercise, you need to set your calculator to radian mode before you start the Conic Graphing application. To do this:

1. Press [MODE].
2. Move the cursor to Radian, and press [ENTER].
3. Press [CLEAR] to exit the mode screen.

Steps:

1. Determine the semi-major and semi-minor axes.
   One astronomical unit = 149.6×10^6 km
   Aphelion = $7304.33 \div 149.6 = 48.83$ AU
   Perihelion = $4434.99 \div 149.6 = 29.65$ AU

   Semi-major axis (which is A) = $\frac{48.83 + 29.65}{2} = 39.24$

   Semi-minor axis (which is B): $\sqrt{A^2 - B^2} = A - 29.65$, then
   $\sqrt{(39.24)^2 - B^2} = 39.24 - 29.65$. then
   $1539.776 - B^2 = (9.59)^2$, then
   $B^2 = 1539.776 - (9.59)^2$, then
   $B = \sqrt{1447.8095} = 38.05$

2. Determine the eccentricity:
   $e = \frac{\sqrt{A^2 - B^2}}{A} = \frac{\sqrt{(39.24)^2 - (38.05)^2}}{39.24} = .24$

3. Determine the distance from the focus to the directrix, or p.
   $p = \frac{B^2}{\sqrt{A^2 - B^2}} \div 2 = 75.48$

4. Start the Conic Graphing application.

5. Select **ELLIPSE** from the CONICS main menu.

6. Press [MODE] to display the CONIC SETTINGS screen.

7. Select **POL** to change the mode to polar.

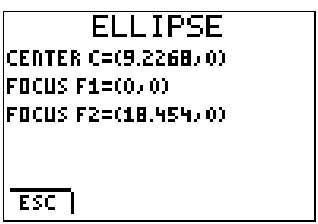
8. Select **MAN** so that you can manually change window settings.

9. Select **ESC** to return to the ELLIPSE screen.

10. Select the equation $\mathbf{R = \frac{2ep}{1 - e\cos(\theta)}}$

11. Enter the values for e and p, as defined above in steps 2 and 3.

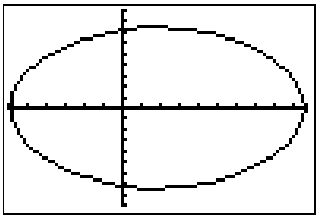
12. Press [ALPHA] [SOLVE] to find the center and foci.



13. Press [WINDOW] to change the CONIC WINDOW settings.

14. Change the following parameters (determined by using the major and minor axis information):
    θmin = 0
    θmax = 2π
    θstep = $\frac{2\pi}{32}$
    Xmin = −30
    Xmax = 48
    Xscl = 5
    Ymin = −45
    Ymax = 45
    Yscl = 5

15. Press GRAPH to graph the orbit.

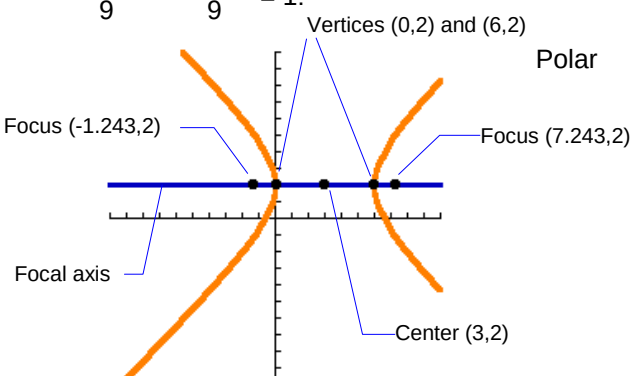


Pluto's orbit around the sun is elliptical, as you would expect. However, it is almost circular. This graph is exaggerated because we did not change the aspect ratio. You can select Zoom Conic to see an unexaggerated graph of Pluto's almost circular orbit.

16. Press TRACE to trace the orbit.

Note Conic Graphing does not allow for continuous tracing. After you trace the entire orbit, the tracing stops. You can then press the opposite direction arrow key to trace the orbit in the opposite direction.

Hyperbolas

Definition	Calculator mode	Equations
A hyperbola is the set of points in a plane whose 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.	Function	$\frac{(X-H)^2}{A^2} - \frac{(Y-K)^2}{B^2} = 1$ $\frac{(Y-K)^2}{A^2} - \frac{(X-H)^2}{B^2} = 1$
	Parametric	$X = A \sec(T) + H$ $Y = B \tan(T) + K$ $X = B \tan(T) + H$ $Y = A \sec(T) + K$
$\frac{(X-3)^2}{9} - \frac{(Y-2)^2}{9} = 1$: 	Polar	$R = \frac{2ep}{1-e\cos(\theta)}$ $R = \frac{2ep}{1+e\cos(\theta)}$ $R = \frac{2ep}{1-e\sin(\theta)}$ $R = \frac{2ep}{1+e\sin(\theta)}$

Example

A lamp with an opaque cylindrical shade 1.5 feet in diameter, 2 feet high has a light bulb located at the center of the shade. It casts a shadow, which is of the form of a hyperbola, on a wall 3 feet from the bulb and parallel to the shade. Assume the origin is at the light bulb. Find the vertices, foci, and slope of the asymptotes of the hyperbola.

Steps:

The equation of the cone of light is $\frac{16X^2}{9} + \frac{16Z^2}{9} - Y^2 = 0$.

The equation of the wall is: $Z = 3$.

1. Substitute z into the equation and solve:

   $\frac{16X^2}{9} + \frac{16(3)^2}{9} - Y^2 = 0$

   $\frac{16X^2}{9} - Y^2 = -16$

   $Y^2 - \frac{16X^2}{9} = 16$

   $\frac{Y^2}{16} - \frac{X^2}{9} = 1$

2. Start the Conic Graphing application.

3. Select **HYPERBOLA** from the CONICS main menu.

4. Press MODE to display the CONIC SETTINGS screen.

5. Select **FUNC** to change the mode to functional.

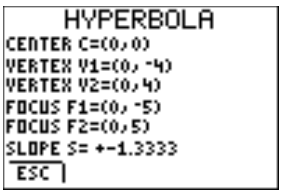
6. Select **MAN** so that you can manually change window settings.

7. Select **ESC** to return to the HYPERBOLA screen.

8. Select the equation $\frac{(Y-K)^2}{A^2} - \frac{(X-H)^2}{B^2} = 1$

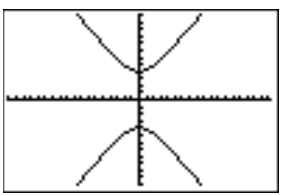
9. Enter the values for A, B, H and K. From the solution in step 1, we know that $A^2 = 16$, $B^2 = 9$ so that $A = 4$, $B = 3$. The problem states that the light bulb is at the origin, so (H,K) is (0,0).

10. Press [ALPHA] [SOLVE] to find the center, vertices, foci, and slope of the asymptotes.

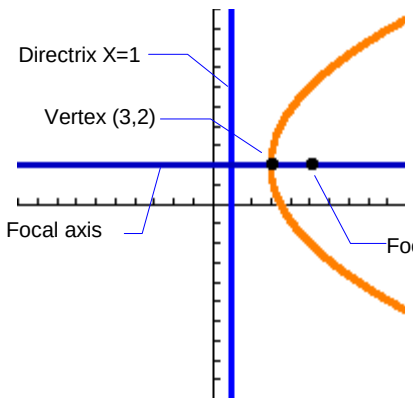


11. Press [ZOOM] to change CONIC ZOOM settings.

12. Select **Zoom Conic**. The graph of the shape of the shadow is drawn.



Parabolas

Definition	Calculator mode	Equations
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. $(Y-2)^2 = 8\,(X-3)$:	Function	$(Y-K)^2 = 4P(X-H)$ $(X-H)^2 = 4P(Y-K)$
	Parametric	$X = AT^2 + H$ $Y = T + K$ $X = T + H$ $Y = AT^2 + K$
	Polar	$R = \frac{2ep}{1-e\cos(\theta)}$ $R = \frac{2ep}{1+e\cos(\theta)}$ $R = \frac{2ep}{1-e\sin(\theta)}$ $R = \frac{2ep}{1+e\sin(\theta)}$

Example

Given the equation of projectile motion and necessary values, find the focus and directrix of the path of the projectile (parabola).

Assume a ball is thrown with a velocity of 65 ft/sec at an angle of $\theta = \tan^{-1}(3/4)$. Assume that the gravitational force is g = 32 ft/sec^2.

Equations of a projectile in motion:	**Givens:**
$X = V_0 \cos(\theta)\, T$	$V_0 = 65$ ft/sec
$Y = V_0 \sin(\theta)\, T - \frac{1}{2} GT^2$	$G = 32$ ft/sec^2
	From $\theta = \tan^{-1}(3/4)$:
	$\cos(\theta) = \frac{4}{5}$
	$\sin(\theta) = \frac{3}{5}$

Steps:

1. Solve for X and Y.

   $X = 65\left(\frac{4}{5}\right)T$

   $X = 52T$, then

   $T = \frac{X}{52}$, then

   $Y = 65\left(\frac{3}{5}\right)T - \left(\frac{1}{2}\right)32\,T2$, then

   $Y = 39T - 16T2$

   Substitute $\frac{X}{52}$ for T: $Y = 39\left(\frac{X}{52}\right) - 16\left(\frac{X}{52}\right)^2$

   Complete the square: $\left(X - \frac{507}{8}\right)^2 = -169\left(Y - \frac{1521}{64}\right)^2$

2. Start the Conic Graphing application.

3. Select **PARABOLA** from the CONICS main menu.

4. Press MODE to display the CONIC SETTINGS screen.

5. Select **PAR** to change the mode to parametric.

6. Select **MAN** so that you can manually change window settings.

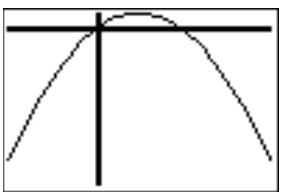
7. Select **ESC** to return to the PARABOLA screen.

8. Select the equation **X = T + H**
   $Y = AT^2 + K$

9. Enter the values for A, H and K:
   $A = -\frac{1}{169}$ $H = \frac{507}{8}$ $K = \frac{1521}{64}$

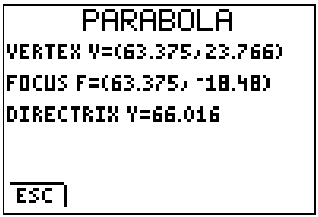
10. Press [ZOOM] to display the CONIC ZOOM window.

11. Select **Zoom Conic**. The graph is displayed.



12. Press [Y=] to escape from the graph screen.

13. Press [ALPHA] [SOLVE] to find the vertex, focus, and directrix.

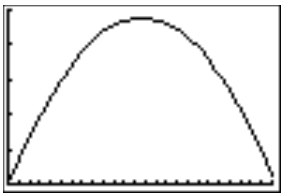


14. Press [WINDOW] to change the CONIC WINDOW settings.

15. Change the following variables to see the graph from the origin.
    Xmin = 0
    Xmax = 125
    Xscl = 5
    Ymin = 0
    Ymax = 25
    Yscl = 5

16. Press GRAPH to graph the parabola.

17. Press TRACE to trace the trajectory.



Glossary

Term	Definition
Asymptote	A straight line associated with a curve such that as a point moves along an infinite branch of the curve, the distance from the point to the line approaches zero and the slope of the curve at the point approaches the slope of the line.
Center	A point that is related to a geometrical figure in such a way that for any point on the figure there is another point on the figure such that a straight line joining the two points is bisected by the original point.
Circle	A closed plane curve in a plane whose distance from a given fixed point in the plane is constant.
Directrix	A straight line the distance to which from any point of a conic section is in fixed ratio to the distance from the same point to a focus.
Eccentricity	A mathematical constant that for a given conic section is the ratio of the distances from any point of the conic section to a focus and the corresponding directrix.
Ellipse	A closed plane curve generated by a point moving in such a way that the sums of its distances from two fixed points is a constant.
Focus	One of the fixed points that with the corresponding directrix defines a conic section (plural: foci).

Term	Definition
Hyperbola	A plane curve generated by a point so moving that the difference of the distances from two fixed points is a constant.
Major axis	The axis passing through the foci of an ellipse.
Minor axis	The chord of an ellipse passing through the center and perpendicular to the major axis.
Parabola	A plane curve generated by a point moving so that its distance from a fixed point is equal to its distance from a fixed line (directrix).
Semi-major axis	One half of the major axis of an ellipse (as that formed by the orbit of a planet).
Semi-minor axis	One half of the minor axis of an ellipse (as that formed by the orbit of a planet).
Slope	The tangent of the angle made by a straight line with the x-axis.
Vertex	A point where an axis of a circle, ellipse, parabola, or hyperbola intersects the curve itself.

Deleting Conic Graphing from the TI-83 Plus

To delete the application from your calculator:

1. From the home screen, press [2nd] [MEM] to display the MEMORY menu.
2. Select Mem Mgmt/Del.
3. Use [▼] or [▲] to select Apps.
4. Use [▼] or [▲] to highlight the application you want to delete with the cursor.
5. Press [DEL].
6. Select Yes.

Error Recovery Instructions

Conic Graphing Application Errors

If the curve does not display or a partial curve displays after you press [GRAPH], the parameters you entered may be outside of the acceptable range for the calculator.

All Equations

If this error occurs or if you receive this error message…	Make this change:
The curve does not display correctly, or a partial curve displays.	The parameters you entered may be outside of the acceptable range for the calculator. If you changed the CONIC SETTINGS window settings mode to **MAN**, press [ZOOM] and select **Zoom Conic** to redefine the window settings.
Window range error or zoom error	Change the window parameters (**Xmin**, **Xmax**, **Ymin**, **Ymax**) so that the window is larger or smaller, depending on the graph.
Invalid input	Change the input to a valid value.

If this error occurs or if you receive this error message…	Make this change:
Requested zoom has invalid results	Change the window parameters (**Xmin**, **Xmax**, **Ymin**, **Ymax**) or **Xfact** and **Yfact** zoom factors. You must exit Conic Graphing to change the **Xfact** and **Yfact** 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-GRAPH LINK 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-GRAPH LINK to remove it and save it on your computer.

Parabolas

If you receive this error message…	Make this change:
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 (Xmin, Xmax, Ymin, Ymax) and/or the p value.
Values out of range for computation. Recheck window settings.	Change the window parameters (Xmin, Xmax, Ymin, Ymax) and/or the p value.

Circles

If you receive this error message…	Make this change:
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: $\sqrt{(-D/A) + (B/2A)^2 + (C/2A)^2} \geq 0$

If you receive this error message…	Make this change:
Values out of range for computation. Recheck window settings.	If the calculator is in **FUNC** or **PAR** mode, change the parameters so that $\frac{A}{B}$ or $\frac{B}{A} < 1\text{E}100$ or $\frac{A}{B}$ or $\frac{B}{A} > 1\text{E}{-}100$. If the calculator is in **POL** mode, change the e or p parameter so that e^2 or $ep < 1\text{E}100$.
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 ≠ 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.

Ellipse

If you receive this error message…	Make this change:
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 $e < 1$.
Allowed parameter values: $p \neq 0$	Change the parameter so that $p < 0$ or $p > 0$.

Installation Error Messages

Low Battery Condition

Do not attempt to download a Flash application if the low-battery message appears on the calculator. Low battery indication is shown on the initial screen. If you receive this error during an installation, change the batteries before trying again.

Archive Full

This error occurs when the TI‑83 Plus does not have sufficient memory for the application. In order to make room for another application, you must delete an application and/or archived variables from the TI‑83 Plus. Before you delete an application from the TI‑83 Plus, you can back it up by using the **Link > Receive Flash Software** menu in TI‑GRAPH LINK for the TI‑83 Plus. You can reload it to the TI‑83 Plus later using the **Link > Send Flash Software** menu in TI‑GRAPH LINK.

Computer to Calculator Communication Error

This error indicates that TI‑GRAPH LINK is unable to communicate with the TI‑83 Plus. The problem is usually associated with the TI‑GRAPH LINK cable and its connection to the TI‑83 Plus and/or to the computer. Make sure the cable is firmly inserted in the calculator I/O port and the computer. Verify that the correct cable type is selected in TI‑GRAPH LINK.

If this does not correct the problem, try a different TI‑GRAPH LINK cable and reboot your computer. If you continue to get this error, please contact TI‑Cares™ Customer Support for assistance.

Calculator to Calculator Communication Error

This problem is usually associated with the unit-to-unit cable and its connection between the TI‑83 Plus calculators. Make sure the cable is firmly inserted in the I/O port of each calculator.

If you continue to get this error, please contact TI‑Cares.

Invalid Signature or Certificate

Either this calculator does not have a certificate to run the application, or electrical interference caused a link to fail. Try to install the application again. If you continue to receive this error, contact TI‑Cares.

Other Errors

See pages B-6 through B-10 in the TI‑83 Plus manual for information about the specific error or contact TI‑Cares.

Verify Operating System Version and ID Number

Conic Graphing is compatible with TI–83 Plus operating system 1.12 and higher.

To verify your operating system version number:

1. From the home screen, press [2nd] [MEM].
2. Select **1: ABOUT**.

The operating system version number is displayed below the calculator name and has the format x.yy. The ID number appears on the line below the product number.

Verify Flash Application Version

1. Press [APPS].
2. Select Conics.
3. Select INFO.

The version number appears on the information screen below the application name.

Check Amount of Flash Application Free Space

1. From the home screen, press [2nd] [MEM].
2. Select 2: MEM MGMT/DEL**...**

Conic Graphing requires at least 33,070 bytes of ARC FREE (Flash) to load the application and 1250 bytes of RAM to run the application.

There are approximately 160K bytes total archive memory in the TI‑83 Plus, and 1.5M bytes in the TI‑83 Plus Silver Edition. For more information about memory and memory management, refer to the TI‑83 Plus manual.

Texas Instruments (TI) Support and Service Information

For general information

E-mail: ti-cares@ti.com

Phone: 1-800-TI-CARES (1-800-842-2737)
For US, Canada, Mexico, Puerto Rico, and Virgin Islands only

Home page: http://education.ti.com

For technical questions

Phone: 1-972-917-8324

For product (hardware) service

Customers in the US, Canada, Mexico, Puerto Rico, and Virgin Islands: Always contact TI Customer Support before returning a product for service.

All other customers: Refer to the leaflet enclosed with your product (hardware) or contact your local TI retailer/distributor.

Works Cited

Larson, Roland E., Robert P. Hostetler, and Bruce Edwards. 1997. Precalculus with Limits: A Graphing Approach. 2d ed. Boston: Houghton Mifflin Company.

NASA Goddard Space Flight Center. 2001. Pluto Fact Sheet. Greenbelt, MD: Author. Retrieved February 9, 2001 from the Planetary/Lunar Sciences database of the National Space Science Data Center on the World Wide Web: http://nssdc.gsfc.nasa.gov/planetary/factsheet/plutofact.html.

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