TEXAS INSTRUMENTS

TI-83 Plus GeoMaster™ Application

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What is the GeoMaster Application?

The GeoMaster™ application is a Flash software application that runs on the TI-83 Plus. Using this application, you can draw and transform objects, working with them interactively. The GeoMaster application also allows you to graph equations from the Y= editor and stat plots on the same screen with objects you draw using GeoMaster tools.
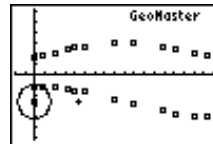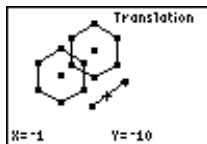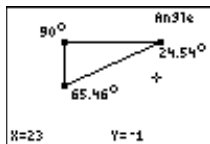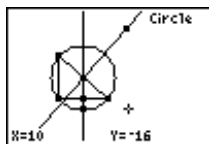
Following are some of the things you can do with the GeoMaster application:

- Draw points, lines, segments, circles, and polygons.

- Translate, reflect, rotate, and dilate objects.

- Measure lengths, areas, perimeters, angles, and determine slope.

- Display equations of circles and lines and coordinates of points.

- Store measured values in TI-83 Plus lists for plotting and analysis.

What You Need

To install and run the GeoMaster™ application, you need:

- A TI-83 Plus calculator with version 1.13 or later of the operating system software to optimize the performance of your calculator and the application. You can download a free copy of the latest operating system software from education.ti.com/softwareupdates.

- TI-GRAPH LINK™ computer-to-calculator cable. If you do not have this cable, call your distributor, or order the cable online from TI's online store.

- 9-pin to 25-pin cable adapter (required only if you are connecting to a 25-pin serial port on the computer).

- TI-GRAPH LINK software that is compatible with the TI-83 Plus. You can download a free copy of this software from education.ti.com/softwareupdates.

Where to Find Installation Instructions

Detailed instructions on installing this and other applications are available at education.ti.com/guides. Follow the link to Flash installation instructions.

Getting Started

Work through this exercise to become familiar with the basic features of the GeoMaster™ application. In this exercise, you draw a triangle that is circumscribed by a circle, and then move the triangle to see what happens to the circle and the perpendicular bisectors.

▶ Start the GeoMaster application.

1. Press [APPS] to display a list of applications on your calculator.

2. Select **GeoMastr**. The information screen is displayed.

Tip | After you press [APPS], you can press [ALPHA] G to move to the first application name that begins with a G.

3. Press any key to continue. The main screen is displayed.

► Draw a triangle.

1. Select **DRAW** (press WINDOW) to display the drawing menu options.

2. Select **Triangle** (move the cursor to Triangle, and then press ENTER, or press 5, the number that corresponds to Triangle).

3. Use the arrow keys to place the cursor where you want the first point of the triangle to start, and then press ENTER.

4. Use the arrow keys to move the cursor away from the point. The first segment is drawn.

5. Press ENTER to create the second point and complete the first segment.

6. Move the cursor away from the second point. The second segment is drawn.

7. Press ENTER to create the third point and complete the second segment.

8. As you draw the second segment, the last segment of the triangle is automatically drawn. To complete the triangle, move the cursor away from the third point.
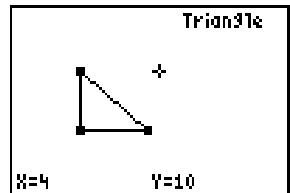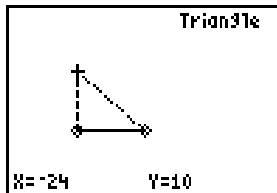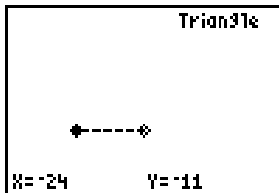
▶ Draw perpendicular bisectors of two sides of the triangle.

1. Press GRAPH to display the menu bar across the bottom of the screen.

2. Select **DRAW**, and then select **Perp Bisector**.

**Tip** | You can press the number (or ALPHA plus the letter) that corresponds to the menu item to select it. For example, to select Perp Bisector, you can press ALPHA **H**.

3. Use the arrow keys to move the cursor to one side of the triangle, and then press ENTER. The perpendicular bisector of that segment is drawn.

Note | You must move the cursor to within two pixels of the triangle segment to draw the perpendicular bisector.

4. Use the arrow keys to move the cursor to another side of the triangle, and then press ENTER. The perpendicular bisector of that segment is drawn.
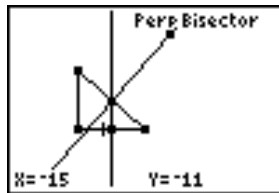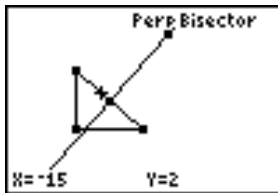
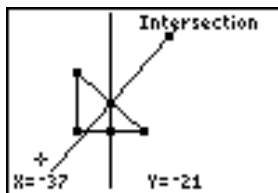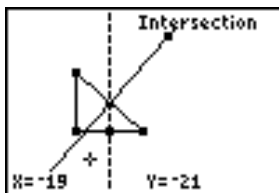► Find the intersection point of the perpendicular bisectors.

1. Press GRAPH to display the menu bar.

2. Select **DRAW**, and then select **Intersection**.

3. Use the arrow keys to move the cursor to one perpendicular bisector, and then press ENTER.

4. Use the arrow keys to move the cursor to the other perpendicular bisector, and then press [ENTER]. The intersection point is drawn.


▶ Draw a circle that circumscribes the triangle.

- The center point is the intersection of the perpendicular bisectors.

- The circle intersects each vertex of the triangle.

1. Press [GRAPH] to display the menu bar.

2. Select **DRAW**, and then select **Circle**.

3. Use the arrow keys to move the cursor to the intersection point of the perpendicular bisectors and press [ENTER].

Note

When more than one object is near the cursor location, a dialog box displays a list of objects that you can choose. Each object is named according its object type. A number follows the name, indicating the order in which that object was created. For example, Point 11 is the name of the 11th point created in this drawing, which is the intersection point of the perpendicular bisectors. Move the cursor to the correct object name and press [ENTER] to select it.
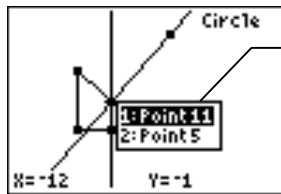
There are 2 objects at this cursor location. Point 11 is the intersection point of the perpendicular bisectors.

4. Use the arrow keys to move the cursor to one of the vertex points of the triangle. The circle enlarges as the cursor moves. Press [ENTER] at the vertex point to complete the circle.

5. Use the arrow keys to move the cursor away from the vertex point. The circle is completed.
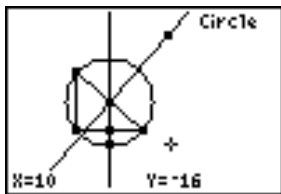
▶ Move a vertex point on the triangle. Notice how the circle, triangle, and the perpendicular bisectors are affected.

1. Press CLEAR to exit the Circle tool.

2. Use the arrow keys to move the cursor to a vertex point on the triangle, and then press ENTER.

Note Select a vertex point other than the one that you used to create the circle.

3. Because the triangle, point, and circle are very close to each other, a dialog box displays that lists the objects you can select. Press $\boxed{\smalltriangledown}$ to highlight the point, and then press $\boxed{\text{ENTER}}$.
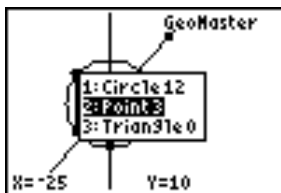
4. Press $\boxed{\text{ENTER}}$ again. An x-shaped cursor is displayed, which indicates that you can move the object you selected.

5. Use the arrow keys to move the point. The circle and the perpendicular bisectors change with respect to the change in the shape of the triangle.
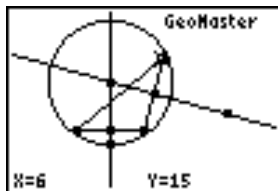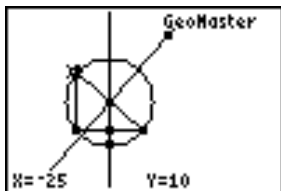
► Save the drawing, clear the screen, and then open the file you created.

1. Press GRAPH to display the menu bar.

2. Select **FILE** (press Y=), and then select **Save File**. The New Filename prompt is displayed. The top right corner displays the alpha-lock icon.

> **Tip** If other GeoMaster™ files have been saved previously, a dialog box lists the names of the GeoMaster files, as well as New Filename. Press ENTER to select New Filename.
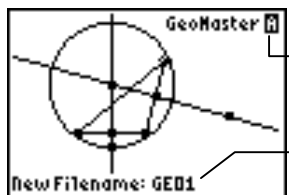
Alpha-lock icon

Press ALPHA to turn the alpha-lock off so that you can enter numbers.

3. Enter a file name, and then press ENTER. The drawing is saved as an application variable (AppVar) with the name you entered.

4. Press GRAPH to display the menu bar.

5. Select **FILE**, and then select **Clear All** to clear the screen.

6. Press ⟨GRAPH⟩ to display the menu bar.

7. Select **FILE**, and then select **Open File**. A dialog box displays the name of the file you just saved.

8. Press ⟨ENTER⟩ to open the file.

Tip If you have other GeoMaster™ files saved on your calculator, all of the files are displayed in the dialog box. Move the cursor to the file name, and then press ⟨ENTER⟩ to open the file.

▶ Quit the application.

1. Press ⟨GRAPH⟩ to display the menu bar.

2. Select **FILE**, and then select **Quit**. The GeoMaster RUNNING screen is displayed.

3. Select **Quit GeoMastr**.

Now that you have completed the Getting Started example, you can read further to learn more about other GeoMaster™ features. For example, you can:

- Draw different types of objects.

- Display information about objects.

- Transform objects.

- Store and clear data.

Starting and Quitting the GeoMaster Application

Starting the Application

1. Press [APPS] to display the list of applications on your calculator.

2. Select **GeoMastr**. The information screen is displayed.

Tip | After you press [APPS], you can press [ALPHA] G to move to the first application name that begins with a G.

3. Press any key to display the main screen.

Note | If the GeoMaster™ application is already running, the GeoMaster RUNNING screen is displayed instead of the information screen. From this screen, select **Continue** to display the main GeoMaster screen.

Quitting the Application

1. Select **FILE** (press GRAPH to display the menu bar, if necessary, and then press Y=), and then select **Quit**. The GeoMaster RUNNING screen is displayed.

2. Select **Quit GeoMastr**.

Note | Pressing 2nd [QUIT] returns the cursor to the home screen, but does not quit the application. You can press GRAPH to return to the main screen.

GeoMaster Settings
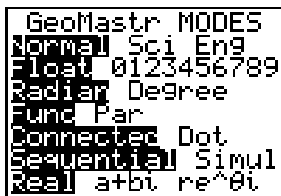
When you run the GeoMaster™ application, several changes are made to your calculator settings. The following table describes these changes:

Setting	Change
Xmin	-47
Xmax	47
Ymin	-31
Ymax	31
Grid	Turned off
Axes	Turned off
Coordinates	Turned on
Graphing mode	Functional
Plots	Turned off
Equations	Turned off
Horizontal or G-T display	Full

You can change these settings at any time, with the following exceptions:

- Polar and sequential graphing modes are not supported.
- Horizontal and graph-table display modes are not supported.

The GeoMaster™ application has its own mode settings screen. This screen does not contain settings that the application does not support. You cannot access the calculator's mode settings screen while the GeoMaster application is running.

When you quit the application, the GeoMaster application turns coordinates and axes on and turns the grid off. The window settings remain unchanged, that is, the last changes you made to the window settings are still in effect. If you have not changed the window settings, the default GeoMaster window settings are still in effect: Xmin = ‑47, Xmax = 47, Ymin = ‑31, Ymax = 31.

Window and Zoom Settings

ZoomCenter (Xmin = ⁻47, Xmax = 47, Ymin = ⁻31, Ymax = 31) is selected when you start the GeoMaster™ application. You can change the window settings; however, the window settings must be within valid ranges. Otherwise, ZoomCenter is automatically selected. Valid ranges are:

Largest window	Smallest window
Xmin ≥ ⁻32000	The following cannot be set at the same time:
Xmax ≤ 32000	
Ymin ≥ ⁻32000	0 > Xmin > ⁻0.01
Ymax ≤ 32000	.01 > Xmax > 0
	0 > Ymin > ⁻0.01
	.01 > Ymax > 0

Using GeoMaster Menus

The GeoMaster™ menu bar is displayed across the bottom of the screen when you start the application. After you select a menu, the menu bar is no longer visible, and the normal functions of the graphing keys are available.

- To select a menu, press the graphing key directly below the menu.

- To select a menu item, highlight the name, and then press ENTER.

- To redisplay the GeoMaster menu bar, press GRAPH.

Tip | Menu items are numbered beginning with 1-9 and continuing with A-Z. After you select the menu, you can press the number (or ALPHA and the letter) that corresponds to the menu item to select it.

Indicates that no tool is selected

Press a graphing key to select a menu.

Coordinates at the cursor location

Tool currently selected

Cursor

Normal functions of the graphing keys are available

TI-83 Plus GeoMaster™ Application
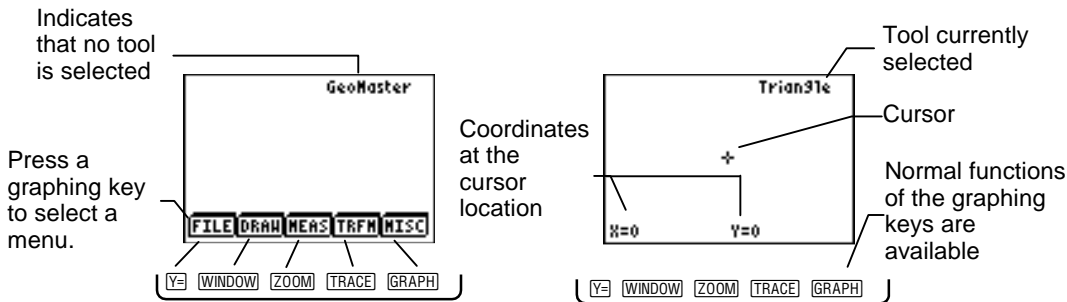
Creating, Saving, and Opening Files

Use the FILE menu to create, save, open, and append files, as well as to clear the screen and exit the application.

Note
- To select the FILE menu, press $\boxed{Y=}$.
- If the GeoMaster™ menu bar is not displayed, press $\boxed{GRAPH}$.
- Press $\boxed{CLEAR}$ to exit the menu item that is currently selected.

Creating a New File

To create a new file, select **New File** from the FILE menu.

Note If the current screen contains objects, the application prompts you to save them to a file.

Opening an Existing File

1. Select **Open File** from the FILE menu. A list of file names is displayed.

2. Select a file name from the list, and then press $\boxed{ENTER}$. The file is displayed.

Note If the current screen contains objects, the application prompts you to save them to a file.

Saving a File

1. Select **Save File** from the FILE menu. A list of file names is displayed.

2. Select **New Filename**, and then type the name for the new file.
   —or—
   Move the cursor to a file name in the list to overwrite an existing file.

Tip Alpha-lock is turned on when you select New Filename. To turn it off so that you can enter numbers, press [ALPHA].

3. Press [ENTER]. The file is saved.

Appending a File to the Current File

1. Select **Append File** from the FILE menu. A list of existing files is displayed.

2. Select a file from the list. The geometric objects of the selected file are appended to the current file.

Note If the file you want to append causes the current file to contain more than 200 objects, an insufficient memory message is displayed, and the selected file is not appended to the current file.

Clearing the Screen

Select **Clear All** from the FILE menu. Every object on the screen is deleted.

Warning | The GeoMaster™ application does not confirm that you want to delete every object on the screen before performing the task.

Drawing Objects

Use the DRAW menu to draw objects such as points, lines, segments, rays, vectors, circles, arcs, and polygons.

Note
- To select the DRAW menu, press WINDOW.
- If the GeoMaster™ menu bar is not displayed, press GRAPH.
- Press CLEAR to exit the menu item that is currently selected.

Drawing a Point

1. Select **Point** from the DRAW menu.

2. Use the arrow keys to move the cursor where you want draw the point.

3. Press ENTER.

4. Press ENTER again or move the cursor away from the point.

Drawing a Line

1. Select **Line** from the DRAW menu.

2. Use the arrow keys to move the cursor where you want to create the first point for the line.

3. Press [ENTER].

4. Use the arrow keys to move the cursor away from the beginning point and draw the line.

5. Press [ENTER], and then move the cursor away from the line.

Drawing a Segment

1. Select **Segment** from the DRAW menu.

2. Use the arrow keys to move the cursor to the beginning point for the segment.

3. Press [ENTER].

4. Use the arrow keys to move the cursor to the ending point for the segment.

5. Press [ENTER], and then move the cursor away from the segment.

Drawing a Circle

1. Select **Circle** from the DRAW menu.

2. Use the arrow keys to move the cursor to the center point of the circle.

3. Press [ENTER].

4. Press any arrow key to expand the circle.

5. When the circle is the size you want, press [ENTER], and then move the cursor away from the circle.

Drawing a Triangle

1. Select **Triangle** from the DRAW menu.

2. Use the arrow keys to move the cursor to the beginning point of the triangle, and then press [ENTER].

3. Move the cursor to draw the first segment of the triangle.

4. Press [ENTER] to place the second point of the triangle.

5. Move the cursor to draw the second segment, and then press ENTER to place the third point of the triangle.

6. Press ENTER or move the cursor to draw the final segment.

Drawing a Polygon

1. Select **Polygon** from the DRAW menu.

2. Use the arrow keys to move the cursor to the beginning point for the polygon.

3. Press ENTER.

4. Move the cursor to draw the first segment of the polygon.

5. Press ENTER to place the second point.

6. Continue to draw segments, pressing ENTER after each segment is complete to place a point.

7. Press ENTER to complete the polygon.

Drawing a Regular Polygon

1. Select **Reg Polygon** from the DRAW menu.

2. Use the arrow keys to move the cursor to where you want to place the center of the polygon.

3. Press [ENTER].

4. Move the cursor until the object is the size you want.

Note The default number of sides is 6, but can be changed in the next step.

5. Press [-] to decrease the number of sides (to a minimum of 3) or press [+] to increase the number of sides (to a maximum of 12).

6. Press [ENTER], and then move the cursor away from the polygon.

Drawing a Ray

1. Select **Ray** from the DRAW menu.

2. Place the cursor at the endpoint for the ray.

3. Press [ENTER].

4. Use the arrow keys to move the cursor away from the endpoint and draw the ray.

5. Press [ENTER], and then move the cursor away from the ray.

Drawing a Vector

1. Select **Vector** from the DRAW menu.

2. Use the arrow keys to move the cursor to the beginning point (the tail) of the vector.

3. Press [ENTER].

4. Move the cursor away from the beginning point.

5. Use the arrow keys to rotate the vector, if needed.

6. Press [ENTER], and then move the cursor away from the vector to place the head of the vector.

Drawing an Arc

1. Select **Arc** from the DRAW menu.

2. Place the cursor at the beginning point of the arc.

3. Press ENTER.

4. Move the cursor to the arc's second point.

5. Press ENTER.

6. Move the cursor to the arc's third point.

7. Press ENTER, and then move the cursor away from the arc.

Drawing a Midpoint

Use the **Midpoint** tool to draw a midpoint on a segment or between two points.

1. Select **Midpoint** from the DRAW menu.

2. Place the cursor on the segment, and then press ENTER to draw the midpoint.

   —or—

   Select the first point, place the cursor on the second point, and then press ENTER to draw the midpoint.

Drawing an Intersection Point

Use the **Intersection** tool to draw an intersection point between two intersecting objects. You can draw an intersection point for any combination of the following types of objects: lines, segments, rays, vectors, circles, and arcs.

1. Select **Intersection** from the DRAW menu.

2. Place the cursor on the first object, and then press ENTER to select it.

3. Place the cursor on the next object, and then press ENTER to select it. The intersection point(s) is drawn.

Drawing a Point on an Object

Use the **Point on Object** tool to draw a point on any existing object.

1. Select **Point on Object** from the DRAW menu.

2. Place the cursor on an object.

3. Press ENTER to draw the point.

Detaching a Point

Use the **Detach Point** tool to detach a point that was created with the **Point on Object** tool.

1. Select **Detach Point** from the DRAW menu.

2. Place the cursor on the point.

3. Press ENTER. The point is detached, but is not deleted.

Drawing a Perpendicular Line

Use the **Perpendicular** tool to draw a line that is perpendicular to a reference object. The reference object can be one of the following: line segment, line, polygon side, triangle side, ray, or vector.

1. Select **Perpendicular** from the DRAW menu.

2. Move the cursor to the reference object, and then press ENTER to select it. The perpendicular line is drawn.

3. Use the arrow keys to move the perpendicular line, if necessary.

4. Press ENTER, and then move the cursor away from the line.

Drawing a Parallel Line

Use the **Parallel** tool to draw a line that is parallel to a reference object. The reference object can be one of the following: line segment, line, polygon side, triangle side, ray, or vector.

1. Select **Parallel** from the DRAW menu.

2. Move the cursor to the reference object, and then press ENTER to select it. The parallel line is drawn on top of the original line.

3. Use the arrow keys to move the parallel line.

4. Press ENTER, and then move the cursor away from the line.

Drawing a Perpendicular Bisector

Use the **Perp Bisector** tool to draw a perpendicular bisector of a reference object. The reference object can be one of the following: line segment, polygon side, triangle side, or vector.

1. Select **Perp Bisector** from the DRAW menu.

2. Select the reference object. The perpendicular bisector is drawn for that object.

Drawing an Angle Bisector

1. Select **Angle Bisector** from the DRAW menu.

2. Select the three points that make up the angle. (The points must be in this order: point, vertex, point.) The angle bisector is drawn.

Tip   Neither intersecting lines nor intersecting line segments have points to select that make up an angle.

To draw an angle bisector of intersecting lines or segments:
- Use the Point on Object tool (DRAW menu) to place exterior points on the lines for the angle, if necessary.

- Use the Intersection tool (DRAW menu) to place a point where the lines intersect.

Calculating and Displaying Measurements

Use the MEAS menu to find information about objects that you have drawn. You can find the following types of measurements:

- slope of a line

- measurement of an angle

- equation of a line

- coordinates of a point

- distance between two points

- length of a vector

- length of a line segment

Note
- To select the MEAS menu, press ZOOM.
- If the GeoMaster™ menu bar is not displayed, press GRAPH.
- Press CLEAR to exit the menu item that is currently selected.

Finding Distance and Length

Use the **Distance/Length** tool to find the distance between two points, length of a line segment or vector, perimeter of a polygon, circumference of a circle, length of an arc, or radius of a circle.

1. Select **Distance/Length** from the MEAS menu.

2. Select the endpoints (for distance). The distance is displayed.

   —or—

   Select the object (for length). The length is displayed.

Tip | The GeoMaster™ application denotes a length measurement by placing a **u** after the value (e.g., 36u).

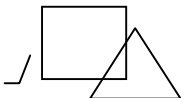3. Use the arrow keys to move the measurement value to any location on the screen, and then press ENTER.

Finding an Area Measurement

Use the **Area** tool to find the area measurement for any size polygon, triangle, or circle.

Note The GeoMaster™ application cannot compute correct area measurements for polygons whose sides cross each other.

Area measurements for either of these polygons can be computed accurately.

The area measurement for this polygon cannot be computed accurately.

1. Select **Area** from the MEAS menu.

2. Move the cursor to the boundary of the object, and press ENTER to select the object. The area measurement is displayed.

Tip The GeoMaster application denotes an area measurement by placing a **u²** after the value (e.g., $1066u^2$).

3. Use the arrow keys to move the measurement value to any location on the screen, and then press ENTER.

Finding an Angle Measurement

Use the **Angle** tool to find the angle measurement of an angle created by selecting any three points. The angle measured is the angle that is inside the three points.

1. Select **Angle** from the MEAS menu.

2. Select the three points that make up the angle. (The points must be selected in this order: point, vertex, point.) The angle measurement is displayed.

Tip   The GeoMaster™ application denotes an angle measurement by placing a ° after the value (e.g., 47°).

3. Use the arrow keys to move the measurement value to any location on the screen, and then press ENTER.

Tip   Neither intersecting lines nor intersecting line segments have points to select that make up an angle.

To create points so that you can calculate angle measurements:
-    Use the [Point on Object tool](#) (DRAW menu) to place exterior points on the lines for the angle, if ncecssary.

-    Use the [Intersection tool](#) (DRAW menu) to place a point where the lines intersect.

Performing Calculations

After you find a measurement using the **Distance/Length**, **Area**, or **Angle** tools, you can add or subtract those values.

Tip
- The Calculate tool only adds or subtracts like values. For example, you cannot add a distance measurement and an area measurement.
- You cannot use a calculated value in a new calculation.
- The Calculate tool does not add or subtract slopes, vector sums, equations, or coordinates.
- The GeoMaster™ application denotes units of measure with the following notation:
  ° for degrees
  u for length
  u^2 for area

1. Select **Calculate** from the MEAS menu.

2. Select the measurement value.

3. To add the measurements, press $+$.

—or—

To subtract the measurements press $-$.

4. Select the next measurement.

Tip | You can add / subtract a maximum of five measurements by repeating steps 4 and 5.

5. Press $\boxed{\text{STO▸}}$ to calculate the sum.

Tip | If you select 6 measurements, you do not have to press $\boxed{\text{STO▸}}$. The sum is automatically calculated.

6. Use the arrow keys to move the calculated value to any location on the screen, and then press $\boxed{\text{ENTER}}$.

Finding the Slope of a Line or Segment

Use the **Slope** tool to find the slope of a line or segment (including a side of a polygon or triangle), vector, or ray.

1. Select **Slope** from the MEAS menu.

2. Select the object. The slope of the object is displayed.

3. Use the arrow keys to move the measurement value to any location on the screen, and then press $\boxed{\text{ENTER}}$.

Drawing a Vector Sum

1. Select **Vector Sum** from the MEAS menu.

2. Select the first vector.

3. Select the second vector. A vector that is the sum of the selected vectors is drawn.

4. Use the arrow keys to move the measurement value to any location on the screen, and then press ENTER.

Finding Equations of Lines or Circles and Coordinates of Points

1. Select **Eqns/Coords** from the MEAS menu.

2. Select the object. The equation (for a line or circle) or the coordinate pair (for a point) is displayed.

3. Use the arrow keys to move the measurement value to any location on the screen, press ENTER, and then move the cursor away from the value.

▶ **Example–**Draw a circle, and then find the equation for that circle. Find coordinate pairs for points on the circle.

1. Draw a circle.

2. Draw a point on the circle using the Point on Object tool.

3. Select **Eqns/Coords** from the MEAS menu.

4. Select the circle. The equation for the circle is displayed.

5. Use the arrow keys to move the equation so that you can read it easily, press ENTER, and then move the cursor away from the equation.

6. Select the point that you just created with the **Point on Object** tool. The coordinates for that point are displayed.

Note Because the circle and the point intersect, a dialog box lists Circle 0 and Point on Object 3. Highlight Point on Object 3, and then press ENTER to select it.

7. Use the arrow keys to move the coordinates so that you can read them easily, press ENTER, and then move the cursor away from the coordinates.

8. Press $\boxed{\text{CLEAR}}$ to exit the **Eqns/Coords** tool.


```
         GeoMaster
 (x+26)^2+(y-0)^2=14^2

     .
              (-12.04,-1)

X=-47       Y=27
```
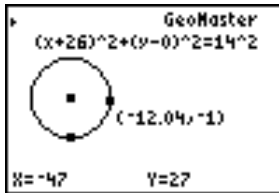
9. Move the cursor to the point that was created with the **Point on Object** tool, and then press $\boxed{\text{ENTER}}$.

10. Press $\boxed{\text{ENTER}}$ again, and then use the arrow keys to move the object to a different location on the circle.

11. Press $\boxed{\text{ENTER}}$ to place the point in the new location. The coordinate pair has been updated with the new coordinates of the point.

Transforming Objects

Use the TRFM menu to translate, reflect, rotate, or dilate an object, or to create an object that is symmetrical to an existing object.

Tip
- To select the TRFM menu, press TRACE.
- If the GeoMaster™ menu bar is not displayed, press GRAPH.
- Press CLEAR to exit the menu item that is currently selected.

Translating an Object

A translation slides a shape a given length in a given direction. A vector defines the length and direction for the translation. The original object is unchanged.

1. Draw an object.

2. Draw a vector that provides the length and direction for the translation.

3. Select **Translation** from the TRFM menu.

4. Select the object to translate.

Note | Move the cursor to the side of the object to select it. You cannot select an object by moving the cursor to the interior of the object.

5. Select the vector. The object is translated.

Note | The order of these steps is important. You *must* first select the object to translate and then select the vector.
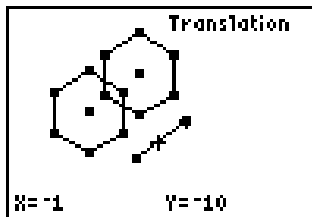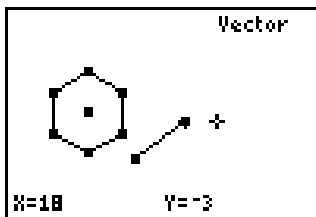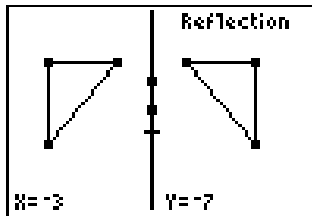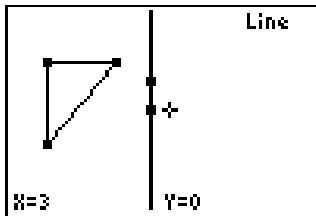

Reflecting an Object

A reflection creates an object's mirror image with respect to a line, segment, ray, or vector. The original object is unchanged.

1. Draw an object.

2. Draw a line, segment, ray, or vector about which the object will be reflected.

3. Select **Reflection** from the TRFM menu.

4. Select the object to reflect.

5. Select the line, line segment, ray, or vector around which the object will be reflected. The object is reflected.

Note The order of these steps is important. You *must* first select the object to reflect, and then select the object around which to reflect it.
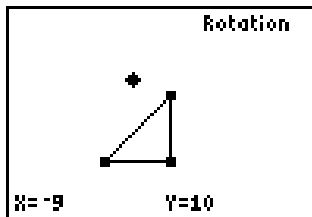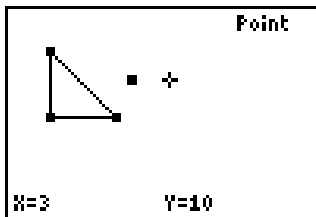

Rotating an Object

1. Draw an object.

2. Draw a point around which the object will be rotated.

3. Select **Rotation** from the TRFM menu.

4. Select the object to rotate.

5. Select the point around which the object will be rotated.

6. Enter the angle of rotation. The object is rotated.

Note
- When you type the first number of the angle of rotation, the angle prompt is displayed.
- The order of these steps is important. You *must* first select the object to rotate, and then select the point around which to rotate it.

The triangle was rotated 90 degrees around the point.

Tip
You can rotate an object in small increments without entering an angle of rotation. To do this:
- Press ⊞ to rotate the object 5° counter-clockwise.
- Press ⊟ to rotate the object 5° clockwise.

You can also rotate an object around its center (or default point, if the object does not have a center, such as a ray) instead of around an external fixed point. To do this, skip steps 1 and 5 above.

Dilating an Object

You can enlarge or reduce an object using the **Dilation** tool. Dilation transforms each segment of an object to a parallel line whose length is a fixed multiple of the length of the original line segment. An object is dilated with respect to a point. When an object is dilated, the original object is deleted.

Tip | Dilation is usually defined as a transformation determined by a center point C and a scale factor k>0. This application also allows k<0.

1. Draw an object.

2. Draw a reference point.

Tip | If you want to dilate an object with reference to its geometric center (or a default point, if the object does not have a center, such as a ray), you do not need to draw a point.

3. Select **Dilation** from the TRFM menu.

4. Select the object to dilate.

5. Select the reference point, unless you want to use the object's geometric center.

6. Enter the factor of dilation.

Tip
- After you enter the first element of the dilation factor, the prompt is displayed.
- You can dilate an object in small increments without entering a factor of dilation:
  - Press ⊞ to dilate the object by a factor of 1.1 of the previous dilation.
  - Press ⊟ to dilate the object by a factor of .9 of the previous dilation.
- If you enter a large dilation factor, the dilated object is not visible in the viewing window.

7. Press ENTER. The object is dilated.
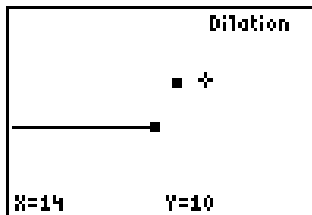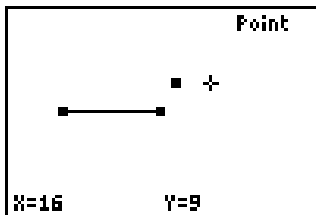
The line segment was dilated with respect to the point by a factor of 1.5.
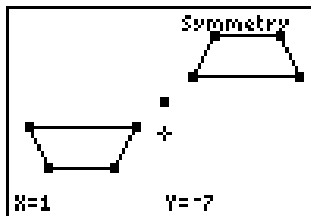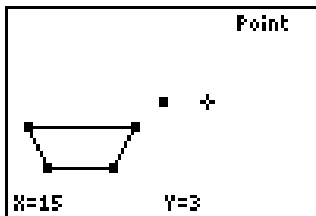
Symmetry

You can use the **Symmetry** tool to do the following:

- Rotate an object 180 degrees about a point.

- Check to see if an object has rotational symmetry of 180 degrees.

- Create special tessellations (cover the geometric plane without gaps or overlaps by congruent plane figures of one type or a few types).

▶ **Example–**Rotate an object 180 degrees about a point.

1. Draw an object.

2. If needed, draw a point about which the object is rotated 180 degrees.

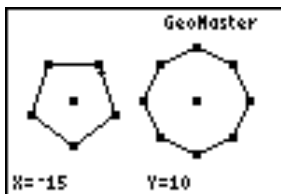3. Select the object, and then select the center point of rotation. The new object is drawn.

Tip The center point of rotation can be a point you have drawn, the center of the object, or a point on the object.

▶ **Example–**Check to see if a pentagon and an octagon have rotational symmetry of 180 degrees.
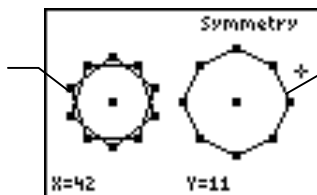
1. Draw a pentagon using the **Reg Polygon** tool.

2. Draw an octagon using the **Reg Polygon** tool.

3. Select **Symmetry** from the TRFM menu.

4. Select the pentagon, and then select the pentagon's center point. The second pentagon, rotated 180 degrees, is drawn.

5. Select the octagon, and then select the octagon's center point. The second octagon, rotated 180 degrees, is drawn.
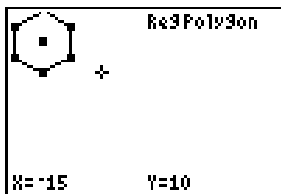
The pentagon does not have rotational symmetry of 180 degrees.

The octagon has rotational symmetry of 180 degrees, that is, the second object matches the first object perfectly.

▶ **Example**–Tessellate the plane using the **Symmetry** tool.

1. Draw a hexagon in the upper left corner of the screen using the [Reg Polygon] tool.

2. Select **Symmetry** from the TRFM menu.

3. Move the cursor to the hexagon, and then press ENTER to select it.

4. Move the cursor to the point on the lower right side of the hexagon, and then press ENTER to select it. A rotated hexagon is drawn about the point that you selected.
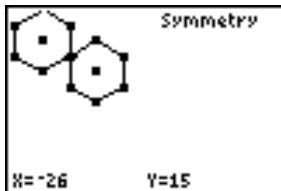
5. Select the rotated hexagon, and then select a point on that hexagon about which to draw the next rotated hexagon.

6. Press ENTER to draw a third rotated hexagon.

7. Continue creating hexagons to tessellate the screen.
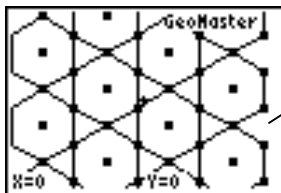
This is a semi-pure tessallation because the plane is tessellated using 2 objects, a regular hexagon and an equilateral triangle.

Comparing Objects

Use the **Perpendicular**, **Parallel**, and **Collinear** tools on the MISC menu to compare two objects.

- The **Perpendicular** tool determines if two lines, segments, vectors, or rays are perpendicular.

- The **Parallel** tool determines if two lines, segments, vectors, or rays are parallel.

- The **Collinear** tool determines if three points are collinear.

The application displays true or false for each comparison. The text disappears when you press ENTER and move the cursor away from its current position.

Tip
- To select the MISC menu, press GRAPH.
- If the GeoMaster™ menu bar is not displayed, press GRAPH.
- Press CLEAR to exit the menu item that is currently selected.
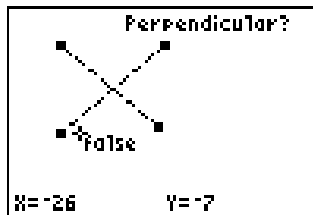
Determining if Two Lines Are Perpendicular

1. [Draw two or more objects](#).

2. Select **Perpendicular?** from the MISC menu.

3. Select the two straight lines. True is displayed for perpendicular lines; false is displayed for non-perpendicular lines.

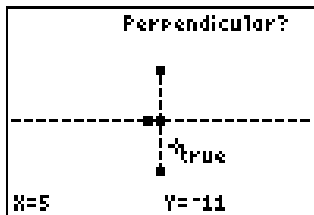**Tip** You cannot compare an object to itself, so you cannot select an object more than one time.

Determining if Two Lines Are Parallel?

1. Draw two or more objects.

2. Select **Parallel?** from the MISC menu.

3. Select the two lines. True is displayed for parallel lines; false is displayed for non-parallel lines.

Tip You cannot compare an object to itself, so you cannot select an object more than one time.
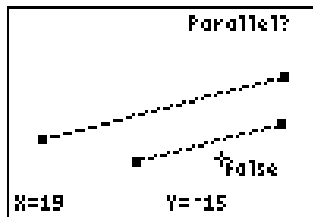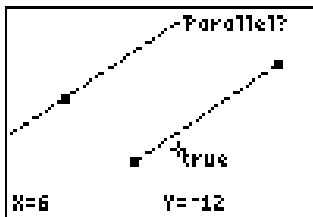
▶ **Example–**Investigate the following theorem: If two parallel lines are cut by transversal (a line that intersects a system of lines), then alternate exterior angles have equal measure.

1. Draw two parallel lines using the Line tool on the DRAW menu, labeling the points **A**, **B**, **C**, and **D** as you create the lines.

Note Press [ALPHA] immediately after you create each point. This allows you to enter a label for each point as you create it. Enter the label, and then proceed.

2. Draw a third line that intersects both of the parallel lines, labeling the points **E** and **F** as you draw the line.
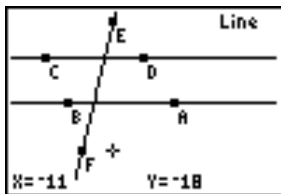
3. Use the [Intersection tool](#) to create the points of intersection for the lines.

4. Select the **Label** tool from the MISC menu.

5. Move the cursor to the first intersection point, and then press ENTER to select it.

Note | A dialog box lists all of the objects at the intersection point. Highlight the point, and then press ENTER to select it.

6. Enter the label **G** for the point, and then press ENTER.

7. Select the second intersection point; enter the label **H** for it; and then press ENTER.

8. Press CLEAR to exit the **Label** tool.

Your screen should look similar to this:
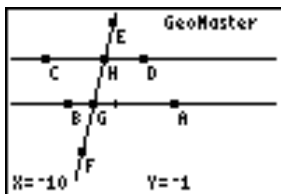
9. [Find the angle measurements](#) for ∠EHD and ∠FGB.

Notice that the alternate exterior angles have equal measure.

10. Press CLEAR to exit the **Angle** tool.

11. Move the cursor to a point on one of the lines, and then press ENTER.

Note ▌ A dialog box lists all of the objects at the intersection point. Highlight the point label, and then press ENTER to select it. ▌

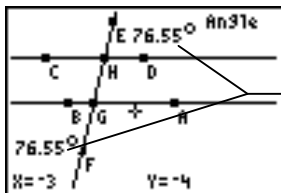12. Press ENTER again, and use the arrow keys to rotate the line.

---

13. Select the **Parallel?** tool from the MISC menu.

14. Move the cursor to the first line, and then press ENTER to select it.

15. Move the cursor to the second line, and then press ENTER to select it. False is displayed, because the lines are no longer parallel. Notice then, if the measurements of the alternate exterior angles are not equal, the lines are no longer parallel.

Before you moved the line, the measurements of the angles were equal.
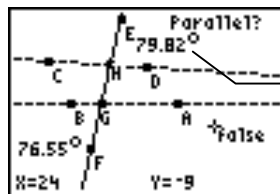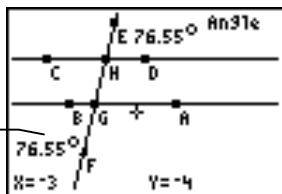
As you move the line, the angle measurements are updated – and are no longer equal!

Determining if Three Points Are Collinear?

1. [Draw an object](#) or draw a [point](#) or [points on an object](#).

2. Select **Collinear?** from the MISC menu.

3. Select the three points. True is displayed for collinear points; false is displayed for non-collinear points.
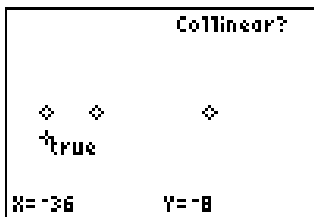
Storing and Clearing Data

Use the **Select Data** and **Clear Data** tools on the MISC menu to work with data gathered using the tools on the MEAS menu.

Tip
- To select the MISC menu, press GRAPH.
- If the GeoMaster™ menu bar is not displayed, press GRAPH.
- Press CLEAR to exit the menu item that is currently selected.

You can store up to six different values or measurements to lists at one time. Each list can contain up to 999 elements. The GeoMaster application automatically creates lists named L1GEO, L2GEO, L3GEO, L4GEO, L5GEO, and L6GEO. The numbers or measurements you select on the screen are stored in these lists with the first element selected stored to L1GEO, the second element stored to L2GEO, etc.

Note
- You may not be able to store the maximum number of elements in each of the six lists if your calculator does not have a sufficient amount of RAM.
- Each coordinate pair is treated as two separate data elements. Therefore, you can only store three coordinate pairs at one time.

Selecting and Storing Data

After you select the data, you can store the data to lists that are automatically created by the GeoMaster™ application (L1GEO – L6GEO). The data you select is appended to the end of the lists. The application saves the lists you created and their data even after you exit the application.

When you select **Select Data**, all of the data elements in the lists L1GEO – L6GEO are cleared, preparing them to have new data elements stored in them. You can store subsequent values to the lists by pressing [STO▶]. For example, you can store the angle measurements of a triangle, and then move a vertex of the triangle and store the new angle measurements. (See the example below.)

1. Draw an object or objects and find measurements or coordinate pairs for the objects.

2. Select **Select Data** from the MISC menu.

3. Select the numbers or measurements on the screen that you want to store.

Note | The cursor must be positioned at the far left end of the data in order to select the data. When the data is selected, it is highlighted.

4. Press $\boxed{\text{STO▶}}$ to store the elements you selected. (You can also select **Store Data** from the MISC menu.)

Note
- If you select enough data for all six lists, the data is stored automatically after you select the last data element. You do not need to press $\boxed{\text{STO▶}}$.
- You can only store three coordinate pairs at one time because the X and Y coordinates are stored in separate lists. (For example, X1 is stored to L1GEO, Y1 is stored to L2GEO, etc.)

▶ **Example–**Investigate the following theorem: The sum of the measure of the angles of a triangle is 180 degrees.

The first series of steps creates the drawing, finds the measurements of the angles, and stores the measurements to L1GEO – L3GEO:

1. Draw a triangle.

2. [Find the measurement](#) of each angle of the triangle.
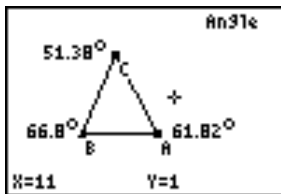
3. [Calculate](#) the sum of the angles.
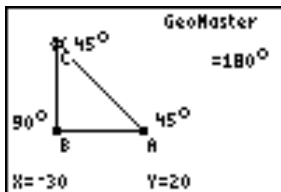
4. Select **Select Data** from the MISC menu.

5. Move the cursor to the first angle measurement, and then press ENTER to select it.

Note | Place the cursor on the leftmost side of the angle measurement to select it. When the measurement is selected, it is highlighted.

6. Move the cursor to the second angle measurement, and then press ENTER to select it.

7. Move the cursor to the last angle measurement, and then press $\boxed{\text{ENTER}}$ to select it.

8. Press $\boxed{\text{STO►}}$ to store the angle measurements to L1GEO – L3GEO.

9. Select a vertex point on the triangle.

Note Move the cursor to the vertex point, and then press $\boxed{\text{ENTER}}$. A dialog box lists all the objects at this location. Highlight the point label, and then press $\boxed{\text{ENTER}}$ to select it.

10. Press $\boxed{\text{ENTER}}$ again, and then use the arrow keys to move the vertex point. The angle measurements are updated as you move the vertex point.

11. Press $\boxed{\text{STO►}}$ to store the new angle measurements.

12. Move the vertex point again, and then press $\boxed{\text{STO►}}$ to store the new angle measurements.

13. Press ENTER to place the vertex in the new location.
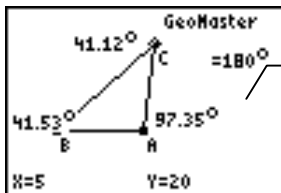
Notice that the angle measurements changed as you moved the vertex point, but the sum of the angles remains the same.

The next series of steps sets up the investigation of the theorem using the list editor. List L1 will contain the sum of the angle measurements of the triangle.

1. Press STAT, and then select **SetUpEditor**.

2. Press 2nd [L1] , 2nd [LIST], and then select **L1GEO**.

3. Press , 2nd [LIST], and then select **L2GEO**.

4. Press , 2nd [LIST], and then select **L3GEO**.

5. Press ENTER to complete the list editor setup.

The next series of steps sets up the sum of the angle measurements in L1, and displays the data in the list editor.

1. Press [ALPHA] ["] [2nd] [LIST], and then select **L1GEO**.

2. Press [+] [2nd] [LIST], and then select **L2GEO**.

3. Press [+] [2nd] [LIST], and then select **L3GEO**.

4. Press [STO▸] [2nd] [L1].

5. Press [ENTER] to complete the setup.

```
SetUpEditor L1, L
L1GEO, LL2GEO, LL3
GEO
              Done
" LL1GEO+ LL2GEO+ L
L3GEO→L1
LL1GEO+ LL2GEO+ L...
■
```

6. Press [STAT] and then select **Edit**.

This symbol indicates that L1 is a locked list. It will be dynamically updated if you change any value in L1GEO – L3GEO.

```
L1      L1GEO   L2GEO   1
180     45      90
180     64.179  62.7
180     109.54  36.431
-----   ------  ------


L1(1)=180
```

You can see that the sum of the angles of the triangle, no matter what its shape, is 180 degrees.

Clearing Stored Data

To quickly clear all data from all of the lists created by the GeoMaster application, select **Clear Data** from the MISC menu. Lists L1GEO – L6GEO are deleted. To return the list editor to the default settings, press [STAT], select **SetUpEditor**, and then press [ENTER].

Tip You can clear list elements instead of deleting the entire list. To do this:
1. Press [2nd] [QUIT] to exit the application.
2. Press [STAT].
3. From the Edit menu, select **ClrList**.
4. Press [2nd] [LIST] to display the lists on your calculator.
5. Select the list to clear and press [ENTER].

Moving Objects

Moving Individual Objects

1. [Draw an object](#).

2. Press CLEAR to exit the current tool.

3. Move the cursor to the object, and then press ENTER. The object changes to dashed lines.

4. Press ENTER again to activate move mode. An x-shaped cursor is displayed.

5. Use the arrow keys to move the object.

Tip | Everything on the screen that is associated with the object is moved with it, including transformations and labels.

6. Press ENTER to place the object in its new location. The normal cursor returns.

7. Move the cursor to an empty area on the screen, and then press ENTER. The object's lines change back to solid lines, indicating that the object is deselected.

Moving Multiple Objects

1. [Draw two or more objects](#).

2. Press CLEAR to exit the current tool.

3. Move the cursor to the first object, and then press ENTER. The object changes to dashed lines.

4. Move the cursor to the second object, and then press 2nd ENTER. The object changes to dashed lines.

5. Select additional objects by moving the cursor to each object and pressing 2nd ENTER.

6. With the cursor on a selected object, press ENTER again to activate the move mode. An x-shaped cursor is displayed.

7. Use the arrow keys to move the group of objects.

Tip | Everything on the screen that is associated with the objects is moved with it, including transformations and labels.

8. Press ENTER to place the objects in their new location. The normal cursor returns.

9. Move the cursor to an empty area on the screen, and then press ENTER. The objects' lines change to solid lines, indicating that the objects are deselected.

GeoMaster Utilities

The MISC menu contains several tools that make working with the GeoMaster™ application easier and more efficient.

- **Pointer** exits the current tool and displays the normal cursor.

- **Label** lets you add a label to any object on the screen.

- **Hide/Show** lets you hide objects and show hidden objects.

- **Equ/Plot Off** turns off both the equations in the Y= editor and the stat plots.

- **Trails On/Off** turns the trails feature on or off.

Displaying the Normal Cursor

To display the normal cursor, select **Pointer** from the MISC menu.

Creating Labels

1. Select **Label** from the MISC menu.

2. Select the object you want to label.

3. Enter the label.

Tip
- A label can contain up to eight characters.
- Alpha-lock is automatically turned on after you select the object you want to label.
- Press ALPHA to turn off the alpha-lock so that you can type numbers.

4. Press ENTER.

Hiding Objects

1. Select **Hide/Show** from the MISC menu.

2. Select the object(s) to hide or show.

3. Press CLEAR. The object is hidden.

Showing Hidden Objects

1. Select **Hide/Show** from the MISC menu. Any hidden objects are displayed with dashed lines.

2. Move the cursor to an object you want to show, and then press $\boxed{\text{ENTER}}$. The object is displayed with solid lines.

Equ/Plot Off

If you have turned on equations in the Y= editor or have turned stat plots on, you can turn them off again without exiting the GeoMaster™ application by selecting **Equ/Plot Off** from the MISC menu. By default, equations and stat plots are turned off when you start the application.

Turning Trails On and Of

To turn trails on or off, select **Trails On/Off** from the MISC menu. Trails are either turned on or off, depending on the previous Trails On/Off selection. By default, trails are turned off when you start the application.

Quick Reference Guide

Navigating

- To move the cursor around the GeoMaster™ screen, use the arrow keys.

- To display the menus, press $\boxed{\text{GRAPH}}$.

- To highlight a tool in a menu, press $\boxed{\blacktriangle}$ and $\boxed{\blacktriangledown}$.

- To select a tool from a menu quickly, press the number or $\boxed{\text{ALPHA}}$ and the letter that corresponds to the tool.

- To cancel the current object being drawn, press $\boxed{\text{CLEAR}}$.

- To exit the current tool and display the normal cursor, press $\boxed{\text{CLEAR}}$.

Storing Data

- Press $\boxed{\text{STO}\blacktriangleright}$ to store data after previously selecting data with the **Select Data** tool on the MISC menu.

Selecting an Individual or Multiple Objects

To select an individual object, place the cursor on the object, and then press ENTER.

To select multiple objects do one of the following:

1. With the cursor in an empty area, press 2nd ENTER to enable multiple object selection.

2. Move the cursor to each object, and then press ENTER.

3. To disable multiple object selection, press CLEAR.

-or-

1. Press ENTER to select the first object.

2. Press 2nd ENTER to select subsequent objects.

3. To disable multiple object selection, press CLEAR.

Deselecting Objects

- To deselect multiple objects at the same time, place the cursor in an empty area, and then press [ENTER].

- To deselect an individual object, place the cursor on an object, and then press [2nd] [ENTER].

Moving Objects

1. With the cursor on an object, press [ENTER] [ENTER].

2. Use the arrow keys to move the object.

3. Press [ENTER], move the cursor away from the object, and then press [ENTER] again to place the object in the new location.

Entering Coordinates for Points

You can enter the exact coordinates to draw points instead of using the arrow keys to move the cursor to those coordinates. Coordinates can have up to two decimal places.

1. Select a drawing tool, and then press [ENTER] to draw the first point.

2. Use the number keys to enter the X coordinate of the first point, and then press ENTER.

3. Use the number pad on the calculator to enter the Y-coordinate of the first point, and then press ENTER. The point moves to the coordinates you entered.

Note

If you enter coordinates with 2-decimal accuracy, the cursor automatically moves from the X-coordinate to the Y-coordinate after you enter the last number for the X-coordinate.

CAUTION: If you press ENTER after you enter the X-coordinate with 2-decimal accuracy, you cannot enter the Y-coordinate.

Entering a Label for a Point

1. Immediately after you create a point, press ALPHA plus the letter to enter a character.

Tip
- Press ALPHA to type an individual alphabetical character.
- Press 2nd [A-LOCK] to turn on the alpha mode so that you can type several alphabetical characters in a row.
- Press ALPHA to turn off the alpha mode.

2. Press ENTER or an arrow key to complete the label.

Deleting Objects

1. With the cursor on an object, press $\boxed{\text{ENTER}}$.

2. Press $\boxed{\text{DEL}}$ to delete the object and all its dependent objects (measurements, constructions, or objects drawn using that object or its points).

Installation Error Messages

Low Battery

Do not attempt to download a Flash application if the low-battery message appears on the TI-83 Plus home screen. 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 save it on your computer using the TI-GRAPH LINK™ software for the TI-83 Plus. You can reload it to the TI-83 Plus later using the TI-GRAPH LINK software.

Link Transmission Error

This error indicates that the TI‑GRAPH LINK™ software 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 the TI‑GRAPH LINK link settings.

- Verify that the correct communications port (Com Port) is selected in the TI‑GRAPH LINK link settings.

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.

Error in Xmit

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™ Customer Support.

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 Customer Support.

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 Customer Support.

Checking Version Numbers and Free Space

Verify Operating System Version and ID Number

The GeoMaster™ application is compatible with TI-83 Plus operating system 1.13 and higher.

To verify your operating system version number:

1. From the home screen, press [2nd] [MEM].

2. Select **ABOUT**.

The operating system version number is displayed below the product 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 **GeoMastr**. The information screen is displayed.

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

You can also access the information screen by selecting **About** from the application's FILE menu.

Check Amount of Flash Application Free Space

1. From the home screen, press 2nd [MEM].

2. Select **Mem Mgmt/Del**.

The GeoMaster™ application requires at least 49,152 bytes of ARC FREE (Flash) to load the application.

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

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For Technical Questions

Phone: 1-972-917-8324

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