TI-89 / TI-92 Plus / Voyage™ 200 Cabri Geometry

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- Where to Find Installation Instructions
- How to contact Support and Service
- End-User License Agreement
- Cabri Geometry Application User Guide

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Cabri Geometry Application User Guide

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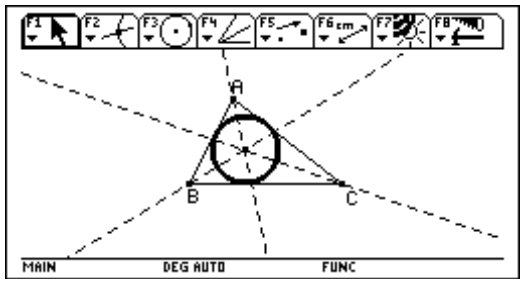
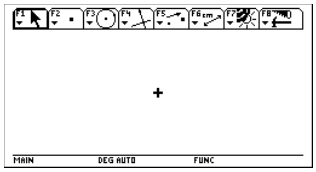
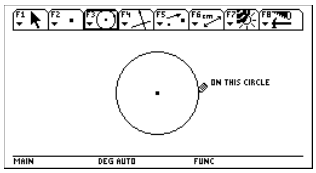
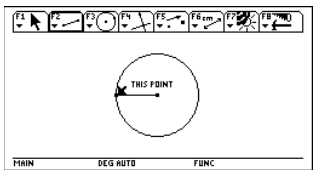
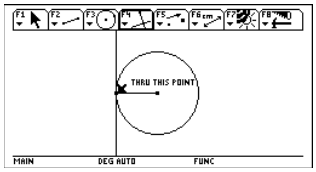
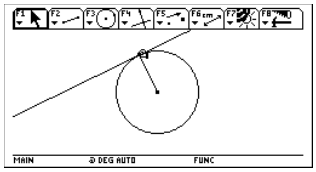
This document describes the Cabri Geometry application for the TI-89 / TI-92 Plus / Voyage™ 200 PLT. It provides descriptions, procedures, illustrations, and examples for using the TI-89 / TI-92 Plus / Voyage 200 PLT to perform analytic, transformational, and Euclidean geometric functions .



Preview of Geometry

Create a circle and construct a perpendicular line that is tangent to the circle.

Steps	TI-89 Keystrokes	TI-92 Plus / Voyage™ 200 PLT Keystrokes	Display
1. Start a new geometry session. *In this example, G2 is the name of the variable. You can use up to eight characters to name constructions (variables).*	APPS ⋮ 3 ENTER ▼ G alpha 2 ENTER ENTER	APPS ⋮ 3 ENTER ▼ G 2 ENTER ENTER	
2. Create a circle. *Pressing ENTER the first time defines the center point. Pressing ENTER the second time draws the circle.*	F3 1 ENTER ▶ (hold momentarily to expand the circle) ENTER	F3 1 ENTER ▶ (hold momentarily to expand the circle) ENTER	
3. Construct a segment from the center of the circle and attach it to the circumference.	F2 5 ◀ (until you see "THIS POINT") ENTER ◀ (until you see "ON THIS CIRCLE") ENTER	F2 5 ◀ (until you see "THIS POINT") ENTER ◀ (until you see "ON THIS CIRCLE") ENTER	
4. Construct a line perpendicular to the segment at the intersection point of the segment and the circle. *Observe each displayed message before pressing ENTER.* *The resultant perpendicular line is tangent to the circle.*	F4 1 ENTER ENTER	F4 1 ENTER ENTER	
5. Observe what happens when the endpoint of the segment is dragged around the circle.	Press and hold alpha then press ▲	Press and hold ☜ then press ▲	

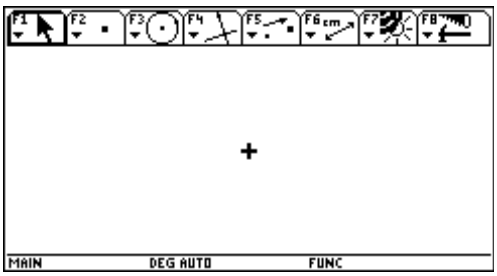
Learning the Basics

This section describes the basic operations that you need to know, such as selecting items from the various menus, navigating with the cursor pad, and starting a construction.

Starting Geometry

To start a new geometry session:

1. Press [ON].
2. Press [APPS] and select Cabri, then 3:New
3. Type a variable name in the New dialog box and press [ENTER] twice. The Cabri Geometry application window opens as shown below.



You construct objects in the active drawing window. The TI-89 drawing window is 158 pixels horizontally and 76 pixels vertically. The TI-92 Plus / Voyage 200 PLT drawing window is 239 pixels horizontally and 103 pixels vertically.

Important: *Cabri Geometry requires 25 Kbytes minimum of free memory*

Note: *The variable name can be up to eight characters.*

Selecting a Tool/Command

The toolbar is comprised of eight separate menus that are selected when you press the function keys. Each menu in the toolbar contains an icon that graphically illustrates a geometry tool or command. The active menu is framed as shown by the first menu item in the previous figure. The table on the next page lists the menu function keys.

On the TI-89, press:	On the TI-92 Plus / Voyage™ 200 PLT press:	
F1	F1	to perform freehand transformations.
F2	F2	to construct points or linear objects.
F3	F3	to construct curves and polygons.
F4	F4	to build Euclidean constructions and create macros.
F5	F5	to build transformational geometry constructions.
2nd F6	F6	to perform measurements and calculations.
2nd F7	F7	to annotate constructions or animate objects.
2nd F8	F8	to perform file operations and edit functions.

To select tools or commands in a menu, press the number that corresponds to the menu item or use the cursor pad to move up and down through the menu and press ENTER to select the highlighted menu item.

For most menu items, once a menu item is selected, it remains in effect until another menu item is selected. The exceptions default to the **Pointer** tool; they are the **Define Macro** tool in the **Construct** toolbar menu and all **File** toolbar menu items.

Moving the Cursor

To move the current active cursor in one of eight directions, press the cursor pad: up, down, left, right, and the four corresponding diagonals on the TI-92 Plus. On the TI-89 / Voyage 200 PLT, hold down any two adjacent cursor keys to move diagonally. The cursor moves one pixel for each keypress. When used in combination with the **TI-89:** alpha or **TI-92 Plus / Voyage 200 PLT:** ⎋ key, the cursor moves one pixel for each keypress and five pixels in repeat mode (cursor pad is held down).

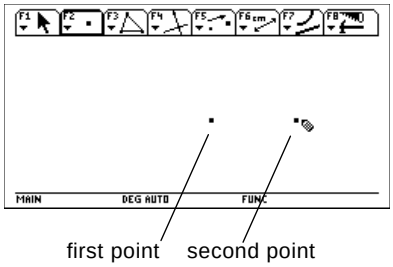
Placing Points

All objects are constructed using one or more points. You create or select points when a tool is active. The order of operation is:

1. Select a construction tool.
2. Create or select the required points that define the object.

To create a point, select the **Point** tool and press ENTER. You can create points anywhere in the plane when the construction pencil is active. For example, to construct the two points in the plane below:

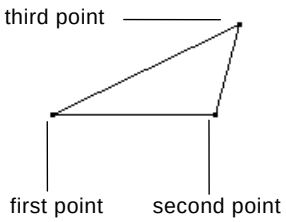
1. Press F2 and select 1:Point.
2. Move the cursor to the desired location and press ENTER to create the first point.
3. To create the second point, press the right side of the cursor pad until the cursor is at the desired location then press ENTER.



Creating a Simple Triangle

All other objects require multiple points to complete their construction. For example, to construct a triangle, you create three points as shown below:

1. Press F3 and select 3:Triangle.
2. Move the cursor to the desired location and press ENTER to define the first point.
3. Move the cursor to another location, and press ENTER to define the second point.
4. Move the cursor to the third location and press ENTER again to complete the triangle.



Selecting Objects

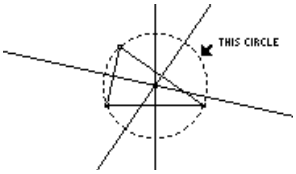
To select objects, point to the object and press [ENTER] or draw a marquee (dotted) rectangle around the objects. To deselect selected objects, move the cursor to an unoccupied location in the plane and press [ENTER].

Selecting one object.

1. Move the cursor using the **Pointer** tool until the object's name appears and press [ENTER].

   The selected object appears as a marquee outline.

Select an object.



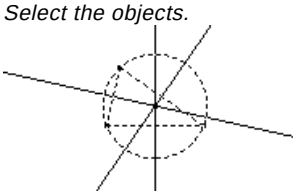
Method #1: Selecting multiple objects.

Hint: Press [↑] when pressing [ENTER] to select multiple objects.

1. Move the cursor using the **Pointer** tool until the object's name appears, then hold [↑] and press [ENTER].
2. Repeat step 1 for other objects that you want to select (the circle and triangle in this example).

   All selected objects appear as a marquee outline.

Select the objects.



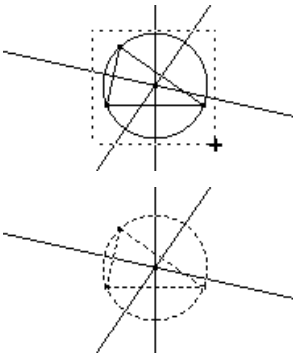
Method #2: Selecting multiple objects.

Note: The Pointer must begin in an unoccupied location in the plane.

1. Press and hold
   TI-89: [alpha]
   [⌨]: [✎]
   TI-92 Plus / Voyage™ 200 PLT: [✎]
   and press the cursor pad to draw a marquee rectangle around the objects that you want to select.
2. Release
   TI-89: [alpha]
   TI-92 Plus / Voyage 200 PLT: [✎]
   (The circle, triangle, and their points are selected in this example.)

   All selected objects appear as a marquee outline.

Draw a marquee rectangle around the objects.



Deleting Objects

To delete objects, select them using the procedures described on the previous page and press ← (backspace key) or **TI-89:** 2nd F8
TI-92 Plus / Voyage™ 200 PLT: F8 then select 7:Delete (delete option in the **File** toolbar menu).

Labeling Points and Objects

You can label points and objects in the following two ways:

- As you create them (see below).
- With the Label tool in the **Display** menu (see page 60).

Labeling objects as they are created is intended for quick access and is limited to five alphanumeric characters. Label editing is not available; however, after constructing the object, you can edit a label with the **Label** tool.

1. Press F3 and select 3:Triangle.

Note: *A point appears with a label "a" beside it.*

2. Move the (↖) cursor to the desired location and press ENTER to create the first point. Press
TI-89: alpha A
TI-92 Plus / Voyage 200 PLT: A

Define and label the first point.

Note: *Another point, a segment connecting the two points, and a label "b" appear.*

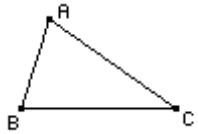
3. Move the cursor and press ENTER to create the second point then press
TI-89: alpha B
TI-92 Plus / Voyage 200 PLT: B

Define and label the second point.

Note*: The completed triangle appears as well as the label "c" beside the last point created.*

4. Move the cursor and press ENTER to create the third point then press
TI-89: alpha C
TI-92 Plus / Voyage 200 PLT: C

Define and label the third point.



Dependent and Independent Objects

You create all objects using one or more points. The manner in which you create an object determines whether or not it is dependent or independent of the object. This distinction becomes important with respect to dragging objects.

A point constructed by itself is called a *basic point*. To identify basic points, select the **Pointer** tool and press **TI-89:** alpha **TI-92 Plus / Voyage 200 PLT:** ↖ once. All basic points will flash and can be dragged.

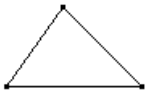
An **independent object** is an object created using only basic points. Independent objects can be moved (dragged) but cannot be modified directly. By moving the basic points used for their construction, you can modify them indirectly.

A **dependent object** is an object constructed using an independent object (or another dependent object). Dependent objects cannot be moved (dragged) or modified directly. You can move or modify them indirectly by moving the basic points or independent objects responsible for their existence.

Dragging Objects

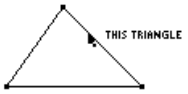
You can move constructed objects that you define with the **Pointer** tool anywhere in the plane. For example, to reposition a constructed object:

1. Construct a triangle as previously described on page 5.
2. Press F1 and select 1:Pointer.



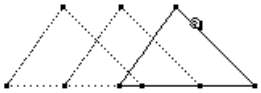
3. Position the (+) cursor until it changes to the (↖) cursor.

   The message "THIS TRIANGLE" appears.



Hint: To lock the cursor in drag mode, press:
TI-89: 2nd [a-lock]
TI-92 Plus / Voyage™ 200 PLT: 2nd ⇪

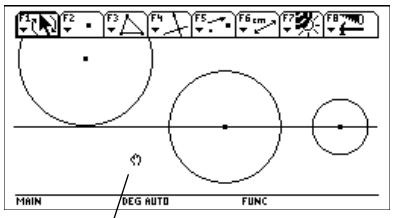
4. Press and hold
   TI-89: alpha
   TI-92 Plus / Voyage 200 PLT: ⇪
   to use the dragging hand then press and hold ▷ to move the triangle to the right.



Positioning a Construction

To scroll the drawing window to anywhere within the virtual working area (see page 58), press 2nd and the cursor pad at the same time. The default position of the active drawing window is at the center of the virtual working area.

1. Construct several geometric objects as shown.
2. Press F1 and select 1:Pointer.
3. Press and hold 2nd then press the cursor pad to scroll all objects in the active drawing window.



Multi-Step Constructions

You perform multi-step constructions by repeating the construction of individual points described in this section. Lines require one point and a direction, line segments require two points, triangles and arcs require three points, and polygons require n points where n is greater than two.

To illustrate the basic steps in this section, the following procedure will construct and measure a circle circumscribed around a triangle.

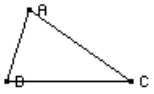
1. Press
   TI-89: 2nd F8
   TI-92 Plus / Voyage™ 200 PLT: F8 and select 3:New.

Start a new construction.

2. Type a name for the variable to start a new construction and press ENTER twice.

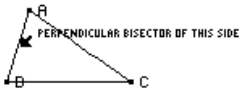
3. Construct and label a triangle. (Perform steps 1 through 4 in "Labeling Points and Objects" described on page 7.)

Construct and label a triangle.

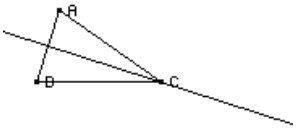


4. Construct perpendicular bisectors for two sides of the triangle by pressing F4 and selecting 4:Perpendicular Bisector.

Construct the first perpendicular bisector.

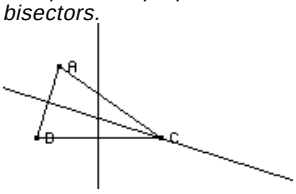


5. Select side AB and press ENTER.



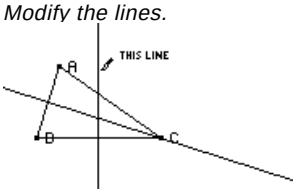
6. Select side BC and press ENTER.

Complete the perpendicular bisectors.

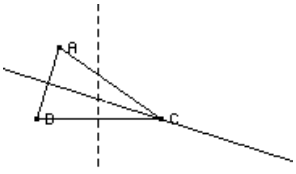


7. Modify the appearance of the perpendicular bisectors from solid to dotted lines by pressing
   TI-89: 2nd F7
   TI-92 Plus / Voyage 200 PLT: F7 and select 9:Dotted.

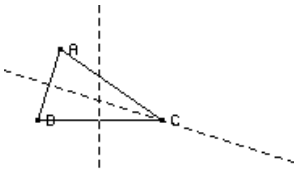
Modify the lines.



8. Select a line and press ENTER.



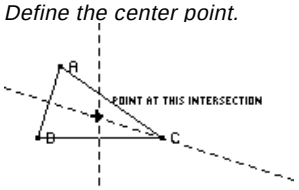
9. Repeat step 8 for the other perpendicular bisector.



10. Press [F3] and select 1:Circle.

11. Define the center point of the circle by moving the cursor near the intersection of the perpendicular bisectors until the message "POINT AT THIS INTERSECTION" appears and press [ENTER].

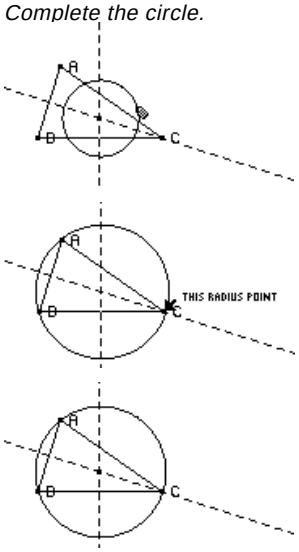
Define the center point.



12. To complete construction of the circle, press the cursor pad ▶ to expand the circle.

    Press the cursor pad (▶ and ▼) until the cursor is near one vertex of the triangle and the message "THIS RADIUS POINT" appears, then press [ENTER] to complete the circle.

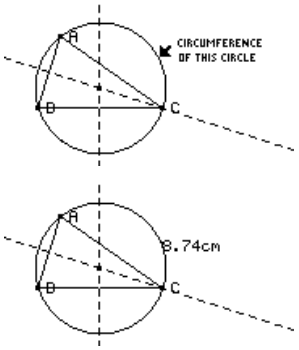
Complete the circle.



13. Measure the circumference of the circle by pressing
    TI-89: [2nd][F6]
    TI-92 Plus / Voyage™ 200 PLT: [F6] and selecting 1:Distance & Length.

14. Position the cursor near the circle until the message "CIRCUMFERENCE OF THIS CIRCLE" appears and press [ENTER].

Measure the circumference.



Using Undo

To undo the last fully constructed object or operation, press
TI-89: 2nd F8
TI-92 Plus / Voyage™ 200 PLT: F8
and select D:Undo.

Hint: *Press* ⌘ Z.

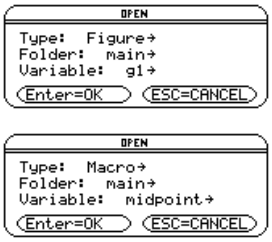
Managing File Operations

The **File** toolbar menu contains file-management commands that let you open, close, and save geometry constructions.

Opening a Construction or Macro

The **Open** command opens a dialog box for opening an existing geometry figure or macro.

1. Press
   TI-89: 2nd F8
   TI-92 Plus / Voyage™ 200 PLT: F8
   and select 1:Open.
2. Select the type of variable that you want to open, Figure or Macro.
3. Press the cursor pad to highlight the variable name that you want to open and press ENTER twice.



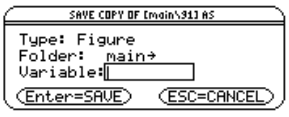
Note: *Pressing ⊙ and selecting* 2:Macro *after selecting the* Open *command lets you open and use a previously saved macro.*

Saving a Construction as Another Name

To preserve memory, the TI-89 / TI-92 Plus / Voyage 200 PLT uses an "edit-in-place" method while you are constructing objects. This means the variable that you named when you first opened the geometry session is constantly updated during your constructions.

The **Save Copy As** command opens a dialog box that lets you save the current construction to a variable name that you specify.

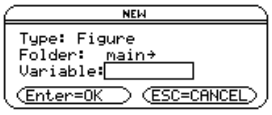
1. Press
   TI-89: 2nd F8
   TI-92 Plus / Voyage 200 PLT: F8
   and select 2:Save Copy As.
2. Enter a name for your construction in the Variable box and press ENTER twice.



Starting a New Construction

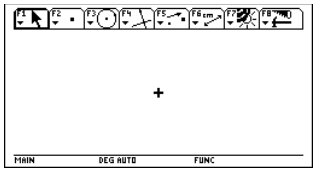
The **New** command opens a new, blank Geometry drawing window for creating a construction or macro.

1. Press
   TI-89: 2nd F8
   TI-92 Plus / Voyage 200 PLT: F8
   and select 3:New.



2. Press ⊖ and enter a name, up to eight characters, for your new construction and press ENTER twice.

   A blank construction area appears.

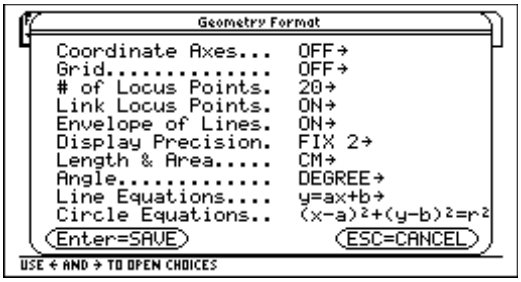


Setting Application Preferences

The **File** toolbar menu contains the **Format** command that opens a dialog box to specify application preferences, such as angles in degrees or radians and the display precision of calculations.

Geometry Format Dialog Box Options

The **Format** command opens the Geometry Format dialog where you specify application preferences. The default formats are shown below.



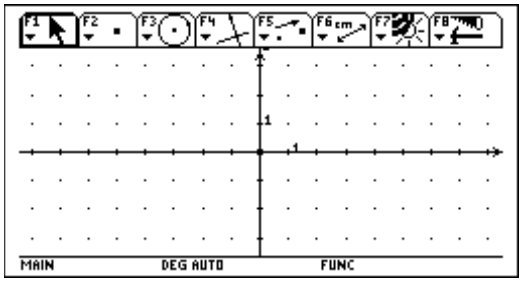
The contents of the Geometry Format dialog box are included in your saved construction files. Consequently, when you open a saved construction, the application returns to the same configuration that was used when you developed the construction.

Defining Application Preferences

1. Press
   TI-89: 2nd F8
   TI-92 Plus / Voyage™ 200 PLT: F8
   and select 9:Format
2. To display all options, press ▼ until the cursor is on the same line as the item that you want to change and press ▶.
3. Select the desired option. (Press the appropriate digit or highlight the option and press ENTER.)
4. To save your changes and close the dialog box, press ENTER.

Format Options and Descriptions

The following table describes each option in the **Geometry Format** dialog box. (Default settings are in boldface.)

Option	Description
Coordinate Axes 1:OFF 2:RECTANGULAR 3:POLAR 4:DEFAULT	Displays the rectangular or polar axes. The default distance for the tick marks is approximately 5 mm each. To change this scale, select any tick mark on the horizontal axis and drag it to a location that approximates the desired scale. All the tick marks in the horizontal and vertical axes will change accordingly. To change the scale for only the y axis, drag any tick mark on the vertical axis. The scale of constructed objects is not affected when you change the coordinate scale. To rotate the axes 360 degrees to redefine the major axes, drag the x axis in a circular direction. You can also rotate the y axis independently to create an oblique coordinate system. Constructed objects do not change.
Grid 1:OFF 2:ON	Displays a grid that is composed of a dot at each coordinate. The example below shows the rectangular coordinate axes with grid marks turned ON. The grid does not represent a polar coordinate system. 
# of Locus Points 5 10 15 **20** ⋮ 99	Determines how many objects will be constructed along the designated path when you construct a locus. The complete option list is: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 99. To modify this value dynamically in your construction, select the locus and press + to increase the number of locus points or − to decrease the number of locus points.

Option	Description
Link Locus Points 1:OFF **2:On**	When this option is ON, the points of a locus are linked by way of linear interpolation. When this option is OFF, only the points are displayed.
Envelope of Lines 1:OFF **2:On**	When this option is ON, only the envelope of the line is displayed when you construct the locus of a line. When this option is OFF, each line of the locus is displayed.
Display Precision 1:FIX 1 **2:FIX 2** ⋮ C:FIX 12	Determines the display precision for calculations and measurements in your constructions. To modify this value dynamically in a construction, select the number and press + or − to increase or decrease the displayed precision of that number.
Length & Area 1:PIXELS 2:MM **3:CM** 4:M	Determines the default units for measurements in your constructions. All values are converted to the selected unit.
Angle **1:Degree** 2:RADIAN	Determines the angle units that are displayed and the geometry calculator mode. All angles are converted to the selected unit. This Angle preference is independent from the Angle preference in the Mode dialog box, which applies to other applications.
Line Equations **1:y=ax+b** 2:ax+by+c=0	Determines the format for displayed line equations.
Circle Equations **1:$(x-a)^2+(y-b)^2=r^2$** 2:$x^2+y^2+ax+by+c=0$	Determines the format for displayed circle equations.

Selecting and Moving Objects

The **Pointer** toolbar menu contains the tools associated with geometry pointer features. These features let you select objects and perform freehand transformations.

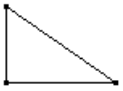
Selecting and Moving Objects Using the Pointer Tool

The **Pointer** tool lets you select, move, or modify objects. Pressing the cursor pad lets you move the **Pointer** in one of eight directions. The primary functions of the **Pointer** are selection, dragging, and scrolling.

To return to the **Pointer** at any time, press ESC.

To see how the **Pointer** tool works:

1. Construct a triangle as previously described.
2. Press F1 and select 1:Pointer.



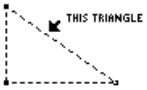
Tip: To select multiple objects, press ↑ while selecting an object.

3. *Selecting:* To select an object, point to it and press ENTER when the cursor message appears for that object.

   To deselect an object, point to an unoccupied location and press ENTER.

Point to the object.

Select the object.

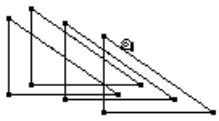


Note: Sometimes multiple objects cannot be moved concurrently. Dependent objects cannot be moved directly. If a selected object cannot be moved directly, the cursor reverts to the cross hair (+) cursor instead of dragging hand cursor.

4. *Moving:* To move an object, drag it to a new location. (Only the last object is actually displayed.)

   To show all the points that can be moved, position the cursor to an unoccupied location and press
   TI-89: alpha
   TI-92 Plus / Voyage™ 200 PLT: ◁
   once. The points that you can drag will flash.

Drag the object.



Deleting Objects from a Construction

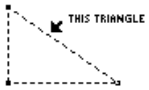
The **File** toolbar menu contains commands that let you delete selected objects or all objects from a construction.

Delete Defined Objects

The **Delete** command lets you delete selected objects.

1. Select the object that you want to delete. (To select additional objects, press ⇧ while selecting each item.)

Select the object.



Note: In this example, only the triangle and not the points of the vertices are selected.

Hint: *Use Undo (♦ Z) to recover an inadvertent deletion.*

2. Press
   TI-89: 2nd F8
   TI-92 Plus / Voyage™ 200 PLT: F8
   and select 7:Delete to delete the selected objects.

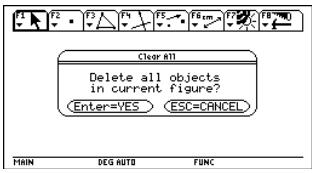
Delete the selected object.

Deleting All Objects

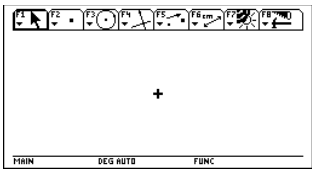
The **Clear All** command deletes every item in the construction and clears the screen.

1. Press
   TI-89: 2nd F8
   TI-92 Plus / Voyage 200 PLT: F8
   and select 8:Clear All.

   A dialog box displays for you to confirm this command.



2. Press ENTER to clear the entire construction area or press ESC to cancel.



Creating Points

The **Points and Lines** toolbar menu contains tools for creating and constructing points in geometry. The three point tools let you create points anywhere in the plane, on objects, or at the intersection of two objects.

Creating Points in Free Space and on Objects

The **Point** tool creates points that can be placed anywhere in the plane, on existing objects, or at the intersection of any two objects.

- If the point created is on an object, it will remain on the object throughout any changes made to the point or to the object.
- If the point is at the intersection of two objects, the point will remain at the intersection when changes are made to the object or objects.
- If the objects are changed such that they no longer intersect, the intersection point disappears. The intersection point reappears when the objects again intersect.

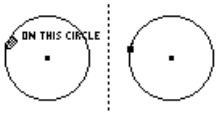
To create points:

1. Press F2 and select 1:Point.
2. *Creating points in free space:* Move the cursor to any location in the plane where you want a point and press ENTER to create the point.

Create points in free space.

3. *Creating points on objects:* Move the cursor to the location on an object where you want a point. When the cursor message appears, press ENTER to create the point.

Create points on objects.

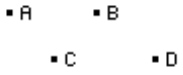


before *after*

Note: *You can attach a label to the point by entering text (five-character maximum) from the keyboard immediately after creating a point.*

4. *Creating points with labels:* Create a point as defined in step 2 or 3 then press an appropriate alphabetic character key to create a label for the point.

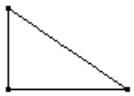
Create points with labels.



Creating a Point on an Object

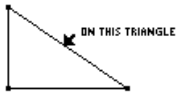
The **Point on Object** tool creates points on any existing object. The point is placed at the location of the cursor. It remains permanently attached to the object—you can drag the point to move it, but it will always remain on the object.

1. Create any object, such as the triangle shown in this example.



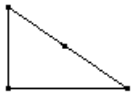
2. Press F2 and select 2:Point on Object.
3. Move the cursor toward the object until a cursor message appears for the object.

Point to the object.



Create the point.

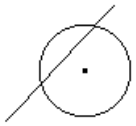
4. Press ENTER to create the point.



Creating an Intersection Point

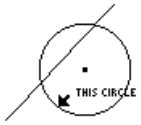
The **Intersection Point** tool creates a point at the intersection (or intersections) of any two defined objects. If the objects are changed so that they no longer intersect, the intersection point disappears. The intersection point reappears when the objects again intersect.

1. Create any two intersecting objects, such as the circle and line shown in this example. (If necessary, see pages 21 and 24.)



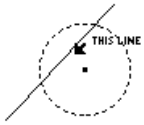
2. Press F2 and select 3:Intersection Point.
3. Select the first object of two intersecting objects then press ENTER.

Select the first object.

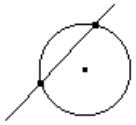


4. Select the second object then press ENTER to create the intersection point or points.

Select the second object.



Points are created at each intersection.



Creating Lines, Segments, Rays, and Vectors

The **Points and Lines** toolbar menu contains tools for creating and constructing linear objects such as lines, segments, rays, and vectors. The **Construction** menu contains a tool for creating resultant vectors.

Creating a Line

The **Line** tool creates a line that extends infinitely in both directions through a point at a specified slope. You can control the slope of the line in free space or create the line to go through another point.

1. Press F2 and select 4:Line.
2. Move the (☝) cursor to the desired location and press ENTER to create the initial point of the line.

Create a point.

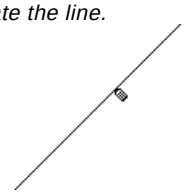
Tip: To limit the slope to 15-degree increments, press ↑ while pressing the cursor pad.

Tip: To label a line, type up to five characters immediately after creating the line or use the Label tool.

3. Move the cursor away from the point to create the line.

   The line is drawn in the same direction as the keypress. When the line appears, you control the slope of the line by continuing to press the cursor pad.
4. Press ENTER to complete the construction.

Create the line.

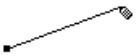


Creating a Segment

The **Segment** tool creates a line segment between two endpoints.

1. Press F2 and select 5:Segment.
2. Move the (☝) cursor to the desired location and press ENTER to create the initial endpoint of the segment.

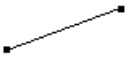
Create the initial point.



Tip: To limit the slope to 15-degree increments, press ↑ while pressing the cursor pad.

3. Move the pointer to the location for the final endpoint of the segment.
4. Press ENTER.

Create the final point.



Creating a Ray

The **Ray** tool creates a ray defined by an initial endpoint and extending infinitely in a specified direction. You can control the slope of the ray in free space or create the ray to go through another point.

1. Press F2 and select 6:Ray.
2. Move the (☝) cursor to the desired location and press ENTER to create the endpoint of the ray.

Create a point.

Tip: *To limit the slope to 15-degree increments, press ↑ while pressing the cursor pad.*

3. Position the ray in the desired orientation using the cursor pad.
4. Press ENTER.

Create the ray.

Creating a Vector

The **Vector** tool creates a vector between two points. A vector is a segment defined by magnitude and direction with a tail (initial endpoint) and head (final endpoint).

1. Press F2 and select 7:Vector.
2. Move the (☝) cursor to the desired location and press ENTER to create the tail of the vector.

Create the tail.

Tip: *To limit the slope to 15-degree increments, press ↑ while pressing the cursor pad.*

3. Move the pointer to the location for the head.
4. Press ENTER.

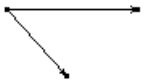
Create the head.

Creating a Resultant Vector

Note: *The selected vectors do not have to share a common endpoint (tail) and may also be previously defined vector sums.*

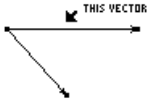
The **Vector Sum** tool in the **Construction** menu creates a resultant vector that is the sum of two selected vectors.

1. Create two vectors as shown in this example.
2. Press F4 and select 7:Vector Sum.



3. Move the pointer and select the first vector.

Select the first vector.

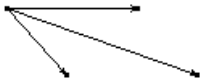


4. Move the pointer and select the second vector.

Select the second vector.

5. Select the initial point for the resultant vector then press ENTER.

Select a tail point for the vector sum.



Creating Circles and Arcs

The **Curves and Polygons** toolbar menu contains the tools for creating and constructing circles and arcs. The **Construction** menu also contains a tool for creating circles.

Creating a Circle Using the Circle Tool

The **Circle** tool in the **Curves and Polygons** menu creates a circle defined by a center point and the circle's circumference. The circumference of the circle also can be attached to a point.

You can resize the circle by dragging its circumference. You can move the circle by dragging the center point.

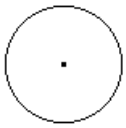
1. Press F3 and select 1:Circle.
2. Move the (☝) cursor to the desired location and press ENTER to create the center point of the circle. Moving the cursor expands the circle.

Create the center point.

Tip: To label a circle, type up to five characters immediately after creating the circle or use the Label tool.

3. Continue to move the cursor away from the center point to specify the radius then press ENTER to create the circle.

Specify the radius and create the circle.



Creating a Circle Using the Compass Tool

The **Compass** tool in the **Construction** menu creates a circle with a radius equal to the length of an existing segment or the distance between two points.

You can change the radius of the circle by dragging the endpoints of the segment that defines the radius. You can move the circle by dragging its center point.

1. Create a segment or two points to define the radius of the circle.

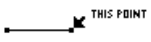
2. Press F4 and select 8:Compass.
3. Move the pointer to the segment, and press ENTER.

Select a *segment.*

Note: The center point can actually be anywhere in the plane.

4. Move the pointer to one of the endpoints of the segment, and press ENTER to create the circle.

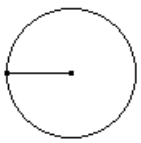
Select a center point.



Note: The first two points determine the radius; the third point becomes the center point of the circle.

5. *(Optional)* Follow the same basic steps to create a compass circle using points. Select three points to perform the construction.

Create the circle.



Creating an Arc

The **Arc** tool creates an arc defined by two endpoints and a curvature point that specifies the curvature of the arc.

1. Press F3 and select 2:Arc.
2. Move the (☝) cursor to the desired location, and press ENTER to create the initial endpoint of the arc.

Create the initial point.

3. Move the pointer away from the initial endpoint.

Move the pointer.

4. Press ENTER then move the cursor to create the curvature point.

Create the curvature point.

5. Move the pointer from the curvature point then press ENTER to create the final endpoint.

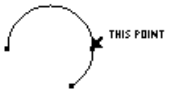
Create the final point.

Resizing an Arc

You can resize an arc or change its curvature by dragging any of the three defined points.

1. Move the cursor to one of the points that define the arc.
2. Press and hold
   TI-89: alpha
   TI-92 Plus / Voyage™ 200 PLT: ⎋
   while pressing the cursor pad to resize the arc.

Drag a point to resize the arc.

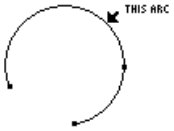


Moving an Arc

You can move the arc by grabbing the arc away from the points that define it and dragging it to a new location.

1. Move the cursor to any location on the arc that is away from the points.
2. Press and hold
   TI-89: alpha
   TI-92 Plus / Voyage 200 PLT: ⎋
   while pressing the cursor pad to move the arc.

Select the arc before dragging to move the arc.



Creating Triangles

The **Curves and Polygons** toolbar menu contains tools for creating and constructing triangles.

Creating a Triangle

The **Triangle** tool creates a triangle defined by three points (vertices).

- **Modifying:** You can modify a triangle by dragging one of its vertices.
- **Moving:** You can move a triangle as an object by grabbing it away from the vertices and moving it to a new location.
- **Moving a point:** You can move a point placed on a triangle along the entire perimeter of the triangle.

1. Press F3 and select 3:Triangle.
2. Move the (↖) cursor to the desired location and press ENTER to create the initial vertex.

Create the first vertex.

Note: *You can limit the slope of its sides to 15-degree increments by pressing ⇧ while constructing the triangle.*

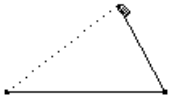
3. Move the pointer from the initial vertex and then press ENTER to create the second vertex.

Create the second vertex.

Note: *An outline of the third side is displayed as you move the cursor.*

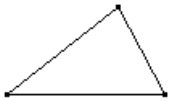
4. Move the pointer to the location for the final vertex.

Locate the final vertex.



5. Press ENTER to create the final vertex to complete the triangle.

Create the triangle.



Creating Polygons

The **Curves and Polygons** toolbar menu contains tools for creating and constructing polygons in geometry.

Creating a Polygon

The **Polygon** tool constructs an n-sided polygon of any shape defined by n points (vertices) where n is a number greater than two.

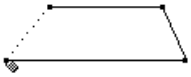
__Tip:__ You can limit the slope of the sides of a polygon to 15-degree increments by pressing ⇧ while constructing the polygon.

1. Press F3 and select 4:Polygon.
2. Move the (☝) cursor to the desired location.
3. Press ENTER to create the initial vertex. Press the cursor pad to create the first side.

Create the initial vertex and the first side.

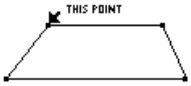
4. Press ENTER then move the pointer to create each of the other vertices.

Create additional vertices.



5. To complete the construction of the polygon:
   - Move the pointer to the initial vertex until "THIS POINT" is displayed and press ENTER.
     — or —
   - Press ENTER a second time on the last point of a polygon.

Select the original point.



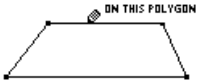
Polygon is complete.

Placing and Moving a Point on a Polygon

You can move a point placed on a polygon along the entire perimeter of the polygon.

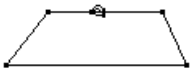
1. Press F2 and select 1:Point.
2. Move the (☝) cursor to the perimeter of the polygon and press ENTER.

Create a point.



3. Press and hold
   TI-89: alpha
   TI-92 Plus / Voyage™ 200 PLT: ◈
   while pressing the cursor pad to move the point along the perimeter of the polygon.

Grab and move the point.



Creating a Regular Polygon

The **Regular Polygon** tool constructs a regular convex or star polygon defined by a center point and n sides.

To begin creating either type polygon, perform steps 1 through 3, then go to the appropriate step 4 depending on the type of polygon that you want to create.

Note: After creating a regular polygon, you can move a point placed on it along the entire perimeter of the polygon. (See previous page.)

1. Press F3 and select 5:Regular Polygon.
2. Move the (☝) cursor to the desired location.
3. Press ENTER to create the center point, press the cursor pad to expand the radius, then press ENTER.

   The number of sides is displayed at the center point. (Default = 6.)

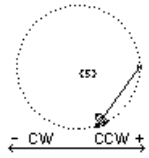
Create the center point.

Specify the radius.

To create a regular *convex* polygon:

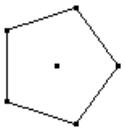
Note: The polygon can have a minimum of 3 and maximum of 17 sides. If you move beyond 17 sides or 180 degrees from the initial vertex and the center point, the convex polygon becomes a star polygon, and a fraction is displayed at the center point.

4. Move the pointer *clockwise* from its current position to decrease (−) the number of sides or *counterclockwise* from its current position to increase (+) the number of sides.



Determine # of sides.

5. Press ENTER to complete the convex polygon.



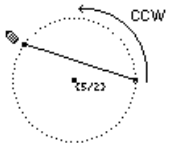
Completed polygon.

To create a regular *star* polygon:

Note: The minimum value is 5/2 and the maximum value is 17/3. The numerator is the number of sides. The denominator is the number of times the star is crossed.

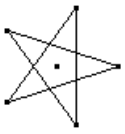
6. Move the cursor *counterclockwise* from its current position until a fraction is displayed at the center point. Continue to move the cursor until the desired number of sides is reached.

Rotate counterclockwise.



7. Press ENTER to complete the star polygon.

Completed polygon.



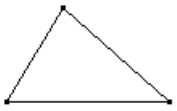
Constructing Perpendicular and Parallel Lines

The **Construction** toolbar menu contains tools for constructing objects in relation to other objects, such as perpendicular and parallel lines.

Constructing a Perpendicular Line

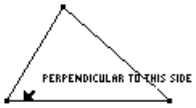
The **Perpendicular Line** tool creates a line passing through a point and perpendicular to a selected linear object (line, segment, ray, vector, side of a polygon, or axis).

1. Create any object having linear properties such as the triangle shown in this example.



2. Press F4 and select 1:Perpendicular Line.
3. Move the cursor to a side or object through which you want the perpendicular line to pass then press ENTER.

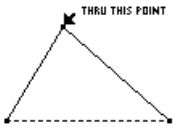
Select a linear object.



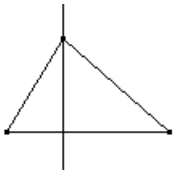
Note: *The order of steps 3 and 4 can be reversed.*

4. Move the cursor to the point through which you want the perpendicular line to pass then press ENTER.

Select a point.



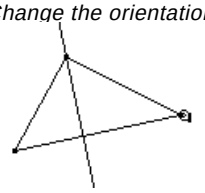
A dependent perpendicular line is drawn.



Note: *You can move the perpendicular line by dragging the point through which the line passes or by changing the orientation of the object to which it is perpendicular.*

5. Drag one of the vertices of the triangle to change its orientation.

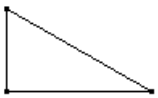
Change the orientation.



Constructing a Parallel Line

The **Parallel Line** tool creates a line that passes through a point and is parallel to a selected linear object (line, segment, ray, vector, side of a polygon, or axis).

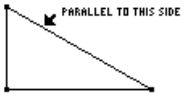
1. Create any object having linear properties such as the triangle shown in this example.



2. Press F4 and select 2:Parallel Line.

3. Move the pointer to the line, segment, ray, vector, or side of a polygon that will be parallel to the constructed line and press ENTER.

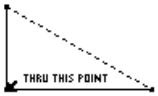
Select a linear object.



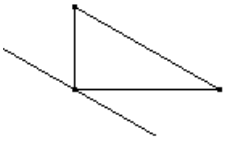
Note: *The order of steps 3 and 4 can be reversed.*

4. Move the pointer to a point through which the parallel line will pass and press ENTER.

Select a point.



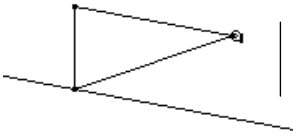
A dependent parallel line is drawn.



Note: *You can move the parallel line by dragging the point through which the line passes or by changing the orientation of the object to which it is parallel.*

5. Drag one of the vertices of the triangle to change its orientation.

Change the orientation.



Constructing Perpendicular and Angle Bisectors

The **Construction** toolbar menu contains tools for constructing objects in relation to other objects, such as perpendicular and angle bisectors.

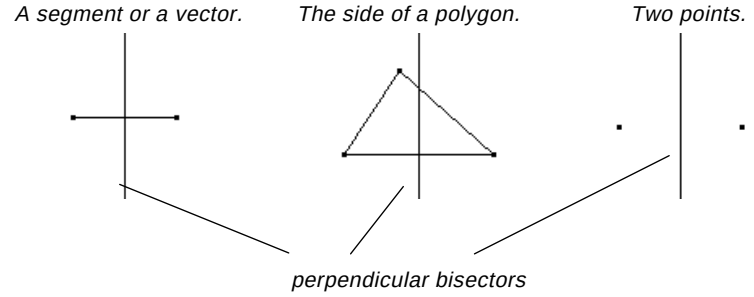
Constructing a Perpendicular Bisector

The **Perpendicular Bisector** tool creates a line that is perpendicular to a segment, a vector, a side of a polygon, or between two points, and passes through the midpoint of the object.

You can move the perpendicular bisector by moving one of the endpoints that define the bisected line segment. A perpendicular bisector cannot be translated directly unless it is constructed between two basic points.

1. Create any object or objects such as those shown below.
2. Press F4 and select 4:Perpendicular Bisector.
3. Move the pointer to one of the following and press ENTER.

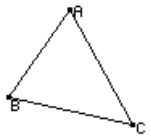
Note: *For two points, select and press ENTER for each point.*



Constructing an Angle Bisector

The **Angle Bisector** tool creates a line that bisects an angle identified by three selected or created points. The second point defines the *vertex* of the angle through which the line passes.

1. Create a labeled triangle such as the one shown in this example.
2. Press F4 and select 5:Angle Bisector.

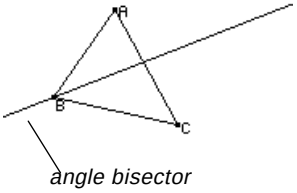


Tip: *You can change the angle bisector by dragging any of the three points that define the angle.*

3. Select three points to define the angle that you want to be bisect. (The second point that you select is the vertex of the angle.)

   The angle bisector is created when you select the third vertex.

Select points A, B, and C.



Creating Midpoints

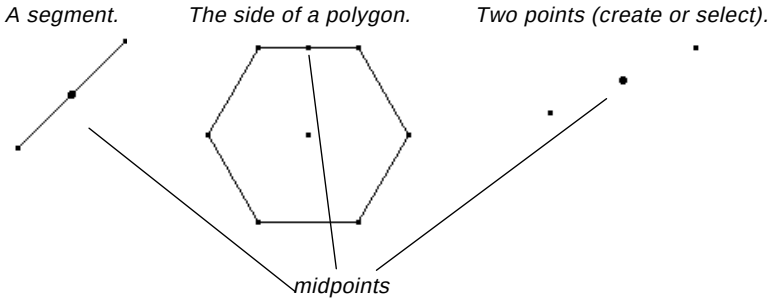
The **Construction** toolbar menu contains a tool for constructing the midpoint of a segment.

Creating a Midpoint

The **Midpoint** tool creates a point at the midpoint of a segment, a vector, the side of a polygon, or between two points.

1. Create any object or objects such as those shown below.
2. Press F4 and select 3:Midpoint.
3. Move the pointer to one of the following and press ENTER.

Note: *For two points, select and press ENTER for each point.*



Transferring Measurements

The **Construction** toolbar menu contains a tool for transferring measurements between objects.

About Transferring Measurements

The **Measurement Transfer** tool creates:

- A point on a ray or vector from the initial point of a line, segment, polygon, or axis.
- A point at a proportional distance from another point.
- A point on a circle that is at an equivalent arc length from another point on the circle.

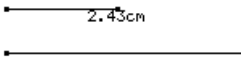
The point created by the measurement transfer is dynamically updated. The magnitude of the measurement that is transferred defaults to the specified unit of length.

Note: See "Measuring Distance and Length of an Object" on page 46 and "Creating and Editing Numerical Values" on page 61 to create the numerical values shown in the examples in this section.

Creating a Measurement Transfer Point on a Ray

Perform the following steps to transfer the measurement of a segment to a ray.

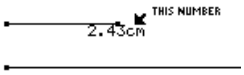
1. Construct and measure a segment, and construct a ray as shown in this example.



2. Press F4 and select 9:Measurement Transfer.

3. Point to any measurement or numerical value, and press ENTER to select the value.

Select a numerical value.

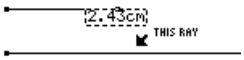


Note: *If you select a point, a dotted line appears. Position the dotted line as you want it, and then press ENTER to set the position.*

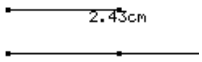
4. Select a ray, vector, polygon, point, or axis; and press ENTER to transfer the measurement to the object.

   A point is created that is an equivalent distance from the endpoint of the ray.

Select a ray.



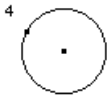
Transfer the measurement.



Creating a Measurement Transfer Point on a Circle

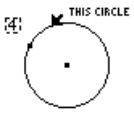
Perform the following steps to create a point on a circle at a proportional arc length away from a selected point.

1. Create a circle with a point on it, then create a numerical value as shown in this example.



2. Press F4 and select 9:Measurement Transfer.
3. Move the cursor and press ENTER to select the numerical value.

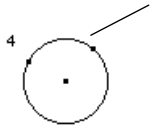
4. Move the cursor and press ENTER to select the circle



Note: *The direction of the distance or arc length is counterclockwise for positive values and clockwise for negative values. The direction is determined by the sign of the selected numerical value.*

5. Move the cursor to the existing point on the circle.

6. Press ENTER to create a point on the circle that is a proportional arc length away from the initial point.



Creating a Locus

The **Construction** toolbar menu contains the Locus tool, which generates a set of points while a point moves along a path.

Creating a Locus

The **Locus** tool creates a set of objects defined by the movement of a point along a path. A path is any defined object on which a point can be placed.

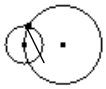
Note: *The number of points calculated in the construction of the locus is defined in the* Geometry Format *dialog box.*

1. Construct two circles as shown.

Construct and attach two circles.

The center point and circumference of the small circle *must be attached* to the circumference of the large circle.

This point indicates that the circles are attached.



2. Press F4 and select A:Locus.

Note: *The locus is dynamically recalculated when you modify the objects that define the locus.*

3. Select the small circle as the object for which to construct the locus.

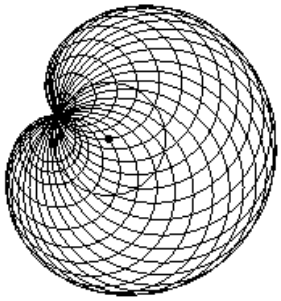
Select the object.

4. Select the center point of the small circle as the point that lies on a path and press ENTER.

Select a point on the path.

When you select a point on a path (object), the locus is constructed in its entirety and is considered a defined object.

The locus is constructed.



Redefining Object Definitions

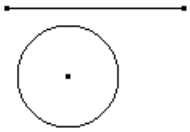
The **Construction** toolbar menu contains the **Redefine Object** tool, which redefines the definition of objects.

Redefining the Definition of an Object

The **Redefine Object** tool modifies the current definition of a point.

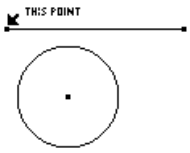
To redefine a point in the following construction:

1. Create a segment and circle as shown in this example.



2. Press F4 and select B:Redefine Object.

3. Move the pointer to a point then press ENTER.



Select the endpoint of the segment.

A pop-up menu opens to let you select a point redefinition option.

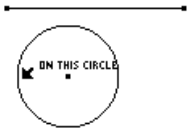
- Point – Redefines the point as a basic point at the same location.
- Point on Object – Redefines the point to be on an object.
- Intersection Point – Redefines the point to be at the intersection of two objects.
- Transfer to another point – Transfers the point to another existing point.

Note: *The new definition cannot be a circular reference. A circular reference occurs when a point that defines an object is redefined to be on that object. For example, defining the center point of a circle to be a point on the circle is not allowed.*

4. Select 2:Point on Object.

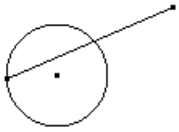
Select a point on the circle.

5. Move the pointer to an object compatible with the selected option, and press ENTER.



The point is redefined.

The segment is attached to the circle.



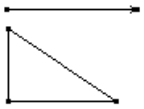
Translating Objects

The **Transformations** toolbar menu contains a tool that is used to translate (copy and move) geometry objects.

Translating an Object

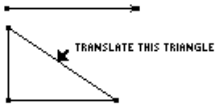
The **Translation** tool creates the image of an object translated by a specified, previously defined vector.

1. Create a vector and triangle as shown in this example.
2. Press F5 and select 1:Translation.



3. Select the object to translate.

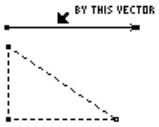
Select the object to translate.



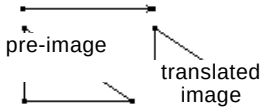
4. Select the vector that defines the translation direction and distance.

   The image of the "pre-image" is translated to the selected location. The pre-image remains in its original location.

Select the translation vector.



The image is translated.



Modifying a Translation

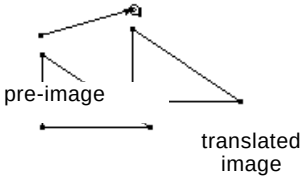
Note: *Because it is a dependent object, you cannot change the translated image directly.*

You can modify a translated image by dragging the vector head to a new location.

- Grab and drag the vector head.
  —or—
- Grab and drag the vector tail to change the magnitude of the translation.

The translated image changes according to the changes made to the vector.

Reposition the vector head.



Rotating and Dilating Objects

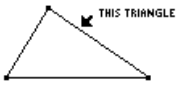
The **Pointer** toolbar menu contains tools to rotate and dilate objects by freehand manipulation. The **Transformations** toolbar menu contains tools for rotating and dilating objects using specific values to create translated images.

Rotating Objects by Freehand

The **Rotate** tool in the **Pointer** menu rotates an object about its geometric center or a defined point.

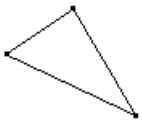
To rotate an object about its geometric center:

1. Create a triangle as shown in this example.
2. Press F1 and select 2:Rotate.
3. Point to the object (not a point) and drag in the direction that you want to rotate the object.



Drag the object around its geometric center

Complete the rotation.

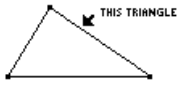


Hint: *Press and hold*
TI-89: alpha
TI-92 Plus / Voyage™ 200 PLT: ⎋
while pressing the cursor pad.

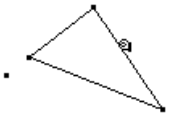
To rotate an object about a defined point:

1. Create a triangle and a point as shown in this example.
2. Press F1 and select 2:Rotate.
3. Select the rotation point. The point will blink on and off.
4. Point to the object and drag in the direction that you want to rotate the object.

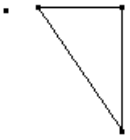
Select the rotation point and grab the object to rotate.



Drag the object around the point



Complete the rotation.



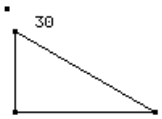
Note: *Move the cursor to an unoccupied location and press* ENTER *to deselect the rotation point.*

Rotating Objects by a Specified Angular Value

The **Rotation** tool in the **Transformations** toolbar menu translates and rotates an object by a specified angular value with respect to a point.

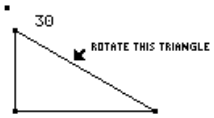
Note: See "Measuring Distance and Length of an Object" on page 46 and "Creating and Editing Numerical Values" on page 61 to create the numerical values shown in the examples below.

1. Create a triangle, a point, and a numerical value as shown in this example.



2. Press F5 and select 2:Rotation.
3. Select the object to rotate.

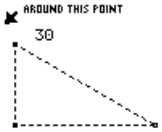
Select the object to rotate.



Note: *The angular value may be any measurement or numerical value regardless of unit assignment. Rotation assumes that the value is in degrees or radians, and is consistent with the* Angle *setting in the* Geometry Format *dialog box. Positive values = CCW rotation. Negative values = CW rotation.*

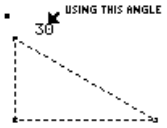
4. Select the point of rotation.

Select the rotation point.



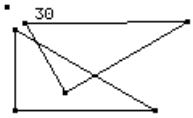
5. Select the angular value of rotation.

Select the angular value.



The rotated image is created. The original object is still displayed at its original location.

The rotated image is created.



Modifying a Rotation

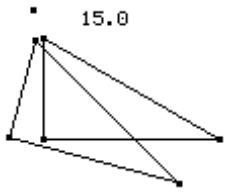
You can modify a rotated image by changing the number that defines the angle of rotation, moving the rotation point, or modifying the original object.

Note: *Because the rotated image is a dependent object, you cannot change it directly.*

1. Select the number, press
   TI-89: 2nd F7
   TI-92 Plus / Voyage™ 200 PLT: F7
   and select 6:Numerical Edit.
2. Change the number to a different value and press ENTER.

   The rotated image moves according to the numerical value that defines the rotation.

The rotated image is modified.

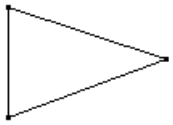


Dilating Objects by Freehand

The **Dilate** tool in the **Pointer** menu expands or contracts an object about its geometric center or a defined point.

To dilate an object about its geometric center:

1. Create a triangle as shown in this example.
2. Press F1 and select 3:Dilate.



Tip: *Press and hold* ***TI-89***: alpha ***TI-92 Plus / Voyage™ 200 PLT:*** ⎋ *while pressing the cursor pad.*

3. Point to the object (not a point) and drag to dilate the object about its geometric center.
4. Drag the object away from its center to expand or toward its center to contract.

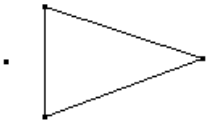
Drag the object.

Complete the dilation.

To dilate an object about a defined point:

1. Create a triangle and a point as shown in this example.
2. Press F1 and select 3:Dilate.
3. Select the dilation point. The point will blink on and off.
4. Point to the object and drag to dilate the object with respect to the dilation point.

Select a dilation point.



Drag the object.

Note: *Dragging an object through the dilation point causes a negative dilation. The cursor must travel through the dilation point.*

5. Drag the object away from its center to expand or toward its center to contract.

Complete the dilation.

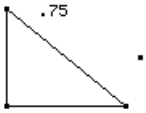
Dilating Objects by a Specified Factor

The **Dilation** tool in the **Transformations** menu translates and dilates an object by a specified factor with respect to a specified point.

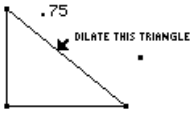
Note: See "Creating and Editing Numerical Values" on page 61 to create the numerical values shown in the examples below.

Note: *Negative numerical values result in a negative dilation.*

1. Create a triangle, a point, and a numerical value as shown in this example.
2. Press F5 and select 3:Dilation.
3. Select the object to dilate.



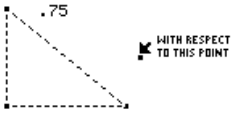
Select the object to dilate.



Note: *The factor can be any measurement or numerical value regardless of unit assignment. Dilation assumes that the selected value is without a defined unit.*

4. Select the point of dilation.

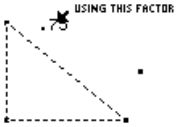
Select the dilation point.



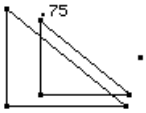
5. Select the factor of dilation.

   The dilated image is created. The original object is still displayed at its original location.

Select the dilation factor.



The dilated image is created.



Modifying a Dilation

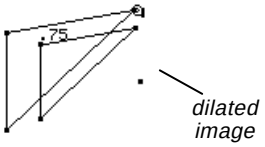
You can modify a dilated image by changing the number that defines the factor of dilation, moving the dilation point, or modifying the original object.

Note: *Because it is a dependent object, you cannot change the dilated image directly.*

1. Grab and drag a vertex of the original object.

   The dilated image moves according to the changes made to the original object.

The dilated image is modified.

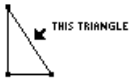


Rotating and Dilating Objects by Freehand

The **Rotate & Dilate** tool in the **Pointer** menu rotates and dilates a selected object about its geometric center or a defined point.

To rotate and dilate an object about its geometric center:

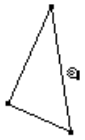
1. Create a triangle as shown in this example.
2. Press F1 and select 4:Rotate & Dilate.



Tip: *Drag the object away from its center to expand, or toward its center to contract. Drag the object in a circular motion to rotate.*

3. Point to the object and drag to rotate and dilate the object.

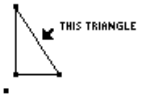
Drag the object in a circular or linear path.



Complete the rotation and dilation.

To rotate and dilate an object about a defined point:

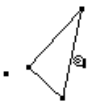
1. Create a triangle and a point as shown in this example.
2. Press F1 and select 4:Rotate & Dilate.
3. Select the point of rotation and dilation. The point will blink on and off.



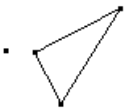
Tip: *Drag the object away from its defined point to expand and rotate or toward its center to contract and rotate.*

4. Point to the object and drag to rotate and dilate the object with respect to the point.

Drag object in a circular or linear path.



Complete the rotation and dilation



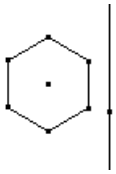
Creating Reflections and Inverse Objects

The **Transformations** toolbar menu contains the tools associated with transformational geometry for creating reflections and inverse objects.

Creating a Reflection

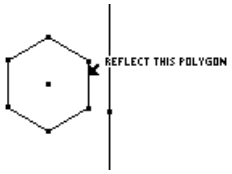
The **Reflection** tool creates a mirror image of an object reflected across a line, segment, ray, vector, axis, or side of a polygon.

1. Create a polygon and a line as shown in this example.
2. Press F5 and select 4:Reflection.



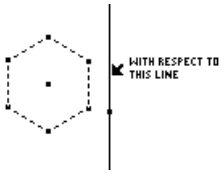
3. Select the object to reflect.

Select the object to reflect.

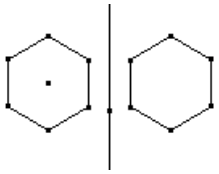


4. Select the line, segment, ray, vector, axis, or side of a polygon to reflect the object across.

Select the linear object.



The reflected object is created.



Modifying a Reflection

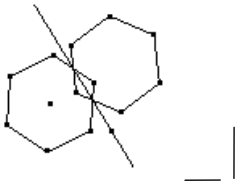
Note: *Because the reflected image is a dependent object, you cannot change it directly.*

You can modify a reflected image by changing the original object or by modifying the line of reflection.

1. Select, reposition, and rotate the line.

   The reflected image moves according to the changes made to the line.

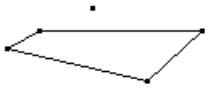
The reflected image is modified.



Creating a Symmetrical Image

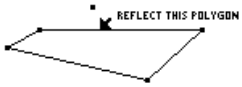
The **Symmetry** tool creates the image of an object that is rotated 180 degrees around a point.

1. Create a polygon and a point as shown in this example.



2. Press F5 and select 5:Symmetry.
3. Select the object to rotate 180 degrees.

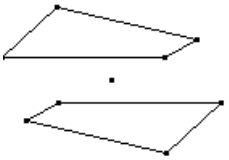
Select the object to rotate.



4. Select the point of symmetry.

Select a point.

The symmetrical image is created.



Modifying a Symmetrical Image

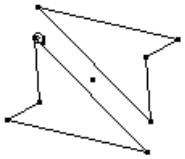
Note: *Because a symmetrical image is a dependent object, you cannot change it directly.*

You can modify a symmetrical image by changing the original object or by moving the point of symmetry.

1. Grab and drag a vertex of the original object. (Upper right vertex of the original object shown in step 1.)

   The symmetrical image is modified according to the changes made to the original object.

The symmetrical image is modified.



Creating an Inverse Point

The **Inverse** tool constructs an inverse point with respect to a circle and a point, according to the equation $OM \cdot OM' = r^2$

where:

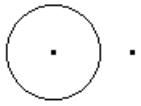
M and M' are points that lie on a ray with endpoint O.

O = center of circle.
M = selected point.
M' = inverse point.
r = radius of selected circle.

As the selected point approaches the center point, the inverse point approaches a point at infinity. If M is defined to be on a line, the locus of M' constructs a circle that passes through the center of the original circle.

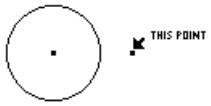
If the original point lies in the interior of the circle, the inverse point is constructed in the exterior, and vice versa. The inverse point lies on a ray with the center point as the endpoint.

1. Create a circle and a point as shown in this example.



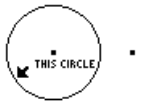
2. Press F5 and select 6:Inverse.
3. Select the point as the original point.

Select a point.

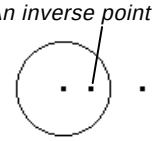


4. Select the circle.

Select a circle.



An inverse point is created.



Modifying an Inverse Point

Note: *Because an inverse point is a dependent point, you cannot change it directly.*

You can modify an inverse point by dragging the point or by modifying the circle that defines it.

1. Grab and drag the original point.

   The inverse point inside the circle moves according to the changed position of the original point.

The inverse point is modified.

Measuring Objects

The **Measurement** toolbar menu contains the tools associated with measurement features in geometry. These features allow you to perform different measurements and calculations on your constructions.

About Measuring Objects

For all measurements described in this section:

- You can add a descriptive comment to a measurement by entering text immediately after creating the measurement, or by using the **Comment** tool in the **Display** toolbar menu.
- You can change the location of a measurement result by dragging it to a different location.

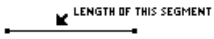
Measuring Distance and Length of an Object

The **Distance & Length** tool measures length, arc length, perimeter, circumference, radius, or the distance between two points.

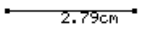
1. Create a segment as shown in this example.

2. Press
   TI-89: 2nd F6
   TI-92 Plus / Voyage™ 200 PLT: F6
   and select 1:Distance & Length.
3. To measure:
   - Length, perimeter, or circumference – Select a segment, arc, polygon, or circle.
   - Distance – Select two points.
   - Radius – Select the center point then select the circumference of the circle.

Select an object.



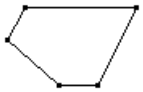
The result is displayed.



Measuring the Area of a Closed Object

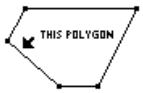
The **Area** tool measures the area of a selected polygon or circle.

1. Create a polygon or circle.

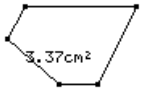


2. Press
   TI-89: 2nd F6
   TI-92 Plus / Voyage 200 PLT: F6
   and select 2:Area.
3. Select the polygon or circle whose area you want to measure then press ENTER.

Select an object.



The result is displayed.



Measuring an Angle

The **Angle** tool measures an angle defined by three selected points or an angle mark. The second point selected is the vertex of the angle. The result is displayed in degrees or radians consistent with the Angle option in the **Geometry Format** dialog box.

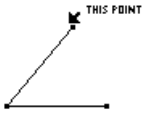
1. Create two segments that have a common point, or any polygon.

2. Press
   TI-89: 2nd F6
   TI-92 Plus / Voyage™ 200 PLT: F6
   and select 3:Angle.

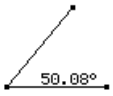
Hint: If an angle mark is displayed on the angle, select the angle mark to measure the angle.

3. Select three points to specify the angle. The second point that you select is the vertex.

Select three points.



The result is displayed.



Measuring the Slope of a Linear Object

The **Slope** tool measures the slope of a selected segment, ray, vector, or line.

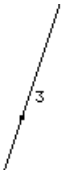
1. Create any linear object.

2. Press
   TI-89: 2nd F6
   TI-92 Plus / Voyage 200 PLT: F6
   and select 4:Slope.

3. Select the segment, ray, vector, or line whose slope you want to measure.

Select an object.

The result is displayed.



Determining Equations and Coordinates

The **Measurement** toolbar menu contains the **Equation & Coordinates** tool that generates and displays equations and coordinates of lines, circles, and points.

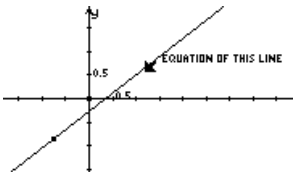
About the Equation & Coordinates Tool

The **Equation & Coordinates** tool displays the equation of a line, circle, or coordinates of a point with respect to a default coordinate system. The equation or coordinates are updated when the object is modified or moved.

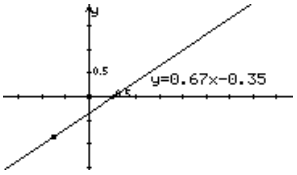
Checking the Equation and Coordinates of a Point or Line

1. (*Optional*) To display the x and y axes, press
   TI-89: 2nd F8
   TI-92 Plus / Voyage™ 200 PLT: F8
   select 9:Format, then select 2:RECTANGULAR from the Coordinate Axes option.
2. Press
   TI-89: 2nd F6
   TI-92 Plus / Voyage 200 PLT: F6
   and select 5:Equation & Coordinates.
3. Select the point or line whose coordinates or equation you want to find.

Select an object.



The result is displayed.

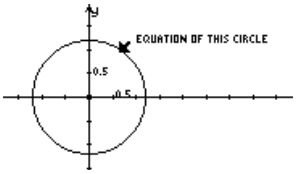


Checking the Equation and Coordinates of a Circle

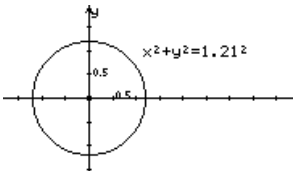
The **Equation & Coordinates** tool displays the equation of a circle with respect to a default coordinate system. The equation or coordinates are updated when the object is modified or moved.

1. (*Optional*) To display the x and y axes, press
   TI-89: 2nd F8
   TI-92 Plus / Voyage 200 PLT: F8
   select 9:Format, then select 2:RECTANGULAR from the Coordinate Axes option.
2. Press
   TI-89: 2nd F6
   TI-92 Plus / Voyage 200 PLT: F6
   and select 5:Equation & Coordinates.
3. Select the circle whose equation you want to find.
4. Select the center point of the circle to find the coordinates of the point.

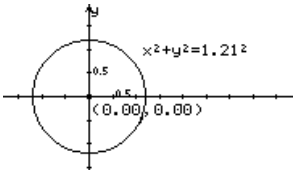
Select an object.



The result is displayed.



Select a point to display its coordinates.



Performing Calculations

The **Measurement** toolbar menu contains the **Calculate** tool that performs measurement calculations on your constructions.

Performing Calculations on Constructed Objects

The **Calculate** tool opens a calculation entry line near the bottom of the screen. The entry line is the interface for entering mathematical expressions involving geometric objects. This tool lets you do the following:

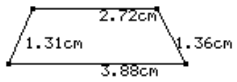
- Perform calculations on constructed objects.
- Access various features of the TI-89 / TI-92 Plus / Voyage™ 200 PLT:.

***Note**: The result of a calculation must be a single floating-point number to be displayed.*

Follow the steps below to perform calculations using measurements, numerical values, calculation results, and numerical inputs from the keyboard.

1. Construct a polygon, and then measure the distance between each point (see page 46).

Construct and measure an object.

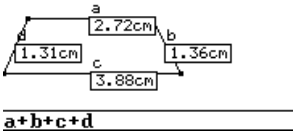


2. To calculate the perimeter, press
   TI-89: 2nd F6
   TI-92 Plus / Voyage 200 PLT: F6
   and select 6:Calculate.

***Note:** The characters assigned to each value are copied from the drawing window and indicate that the value is a variable. The characters are an internal variable representation and do not affect other system-level variables with the same name. You can have up to 10 variables per calculation.*

3. Press ▲ to select the first measurement then press ENTER.
4. Press +.
5. Press ▲ as necessary to select the second, third, and fourth measurements, then press ENTER each time. (Press + before each variable.)

Assign variables.

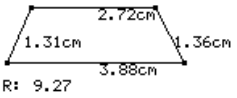


6. With the cursor in the entry line, press ENTER.

   The sum is calculated and displayed after R:.

***Note:** You can recall a calculation by selecting the result and pressing* 2nd ENTER.

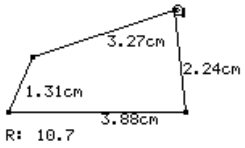
Perform the calculation.



7. To see interactive calculations, grab a vertex of the polygon and drag it to another location.

   Observe the dynamic changes in the result (R:) as the object is changed.

Observe interactive calculations.



Collecting Data

The **Measurement** toolbar menu contains the **Collect Data** tool that lets you define and store data from your constructions into lists for later review in the Data/Matrix Editor.

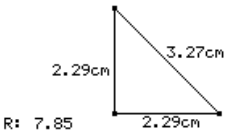
Collecting Data about an Object into a Table

The **Collect Data** tool collects selected measurements, calculations, and numerical values into the variable sysData. You can collect up to 10 data measurements simultaneously.

1. Construct an object, then measure its dimensions.

   For example, measure the sides of a triangle and calculate its perimeter.

Construct and measure.

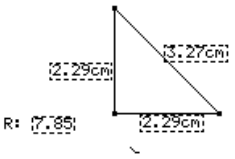


2. Press
   TI-89: 2nd F6
   TI-92 Plus / Voyage™ 200 PLT: F6
   and select 7:Collect Data, and then select 2:Define Entry.

3. Select each measurement and calculated value to define the data to collect.

   The data will appear in the Data/Matrix Editor in the order in which the data was selected.

Define the data to collect.



Tip: *Press*
TI-89: ♦ (-)
TI-92 Plus / Voyage 200 PLT: ♦ H
to place the collected data as a vector in the history area of the Home screen for later review.

4. Press
   TI-89: 2nd F6
   TI-92 Plus / Voyage 200 PLT: F6
   and select 7:Collect Data, and then select 1:Store Data.

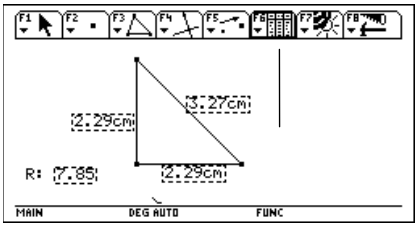
5. Press APPS and select Data/Matrix Editor, then open the variable sysData to display the lists of collected data.

Display the lists.

	N1	N2	N3	R
	c1	c2	c3	c4
1	3.2679	2.2933	2.2930	7.8543
2				
3				
4				
5				

(**Note:** Labels are also copied to the table, if available.)

Note: You can collect defined data entries automatically if the Store Data icon appears in the toolbar while you are animating your construction. (See "Putting Objects in Motion" on page 55).



Checking Properties of Objects

The **Measurement** toolbar menu contains the **Check Property** tool, which allows you to verify specific properties related to a construction.

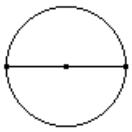
Editing Check Property Text

For all properties described in this section, you can edit the **Check Property** text using the **Comment** tool (see page 61) to customize the result.

Determining If Points Are Collinear

The **Collinear** tool verifies whether or not three selected points lie on the same line.

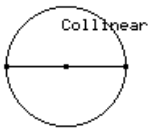
1. Construct a circle and a segment such that the segment passes through the center point and its endpoints are attached to the circle.



2. Press
   TI-89: 2nd F6
   TI-92 Plus / Voyage™ 200 PLT: F6
   select 8:Check Property, and then select 1:Collinear.

3. Point to each endpoint of the segment and the center point of the circle, pressing ENTER each time.

Select three points.

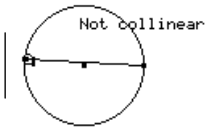


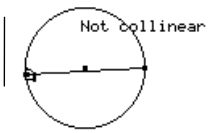
4. Press ENTER to display the property.

Tip: *Position the text box to the desired location before pressing* ENTER *to display the result.*

5. Drag one of the endpoints of the segment a few pixels up and a few pixels down.

Note: *The displayed property changes when the third point (center point) is no longer collinear with the endpoints of the segment.*





Determining If Lines Are Parallel

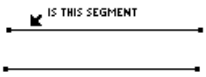
The **Parallel** tool verifies whether or not two lines, segments, rays, vectors, axes, or sides of a polygon are parallel.

1. Construct two segments as shown.

2. Press
   TI-89: 2nd F6
   TI-92 Plus / Voyage™ 200 PLT: F6
   select 8:Check Property, and then select 2:Parallel.

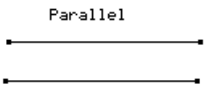
3. Point to the first segment and press ENTER then point to the second segment and press ENTER.

Select the objects.



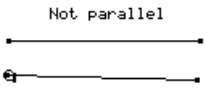
Tip: *Position the text box to the desired location before pressing* ENTER *to display the result.*

4. Press ENTER to display the property of the two segments.



Note: *The displayed property changes when the two segments are no longer parallel.*

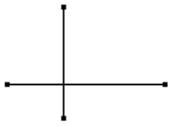
5. Drag the endpoint of one of the segments a few pixels up or down.



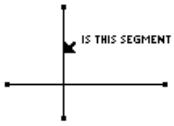
Determining If Lines Are Perpendicular

The **Perpendicular** tool verifies whether or not two lines, segments, rays, vectors, axes, or sides of a polygon are perpendicular.

1. Construct two segments as shown.

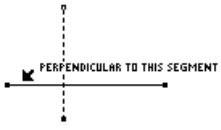


2. Press
   TI-89: 2nd F6
   TI-92 Plus / Voyage 200 PLT: F6
   select 8:Check Property, and then select 3:Perpendicular.



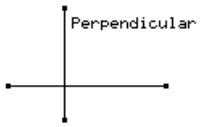
3. Point to each segment, pressing ENTER each time.

Select the objects.



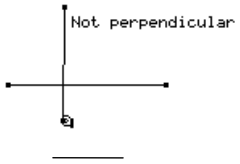
Tip: Position the text box to the desired location before pressing [ENTER] *to display the result.*

4. Press [ENTER] to display the property.



Note: The displayed property changes when the two segments are no longer perpendicular.

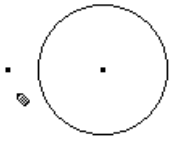
5. Drag the endpoint of one of the segments so that they are no longer perpendicular.



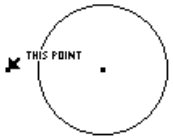
Determining if a Point Lies on an Object

The **Member** tool evaluates a point to dtermine whether or not it lies on an object.

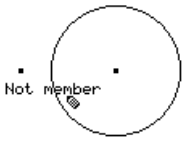
1. Construct a point and a circle as shown to the right.



2. Press
   TI-89: [2nd][F6]
   TI-92 Plus / Voyage™ 200 PLT: [F6]
   and select 8:Check Property, and then select 4:Member.
3. Select the point (point to it and press [ENTER]).



4. Point to the circle and then press [ENTER].
5. If desired, move the empty text box to an easy-to-read location.
6. Press [ENTER] to display the property in the text box.



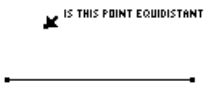
If you drag the point to lie on the circle, the displayed property automatically changes to Member. However, the point must be postioned so that it is *mathematically* on the circle. This may not be easy to do by simply dragging the point of the circle. To position the point mathematically, use **Redefine Object** in the [F4] **Construction** toolbar menu.

Determining if Points are Equidistant

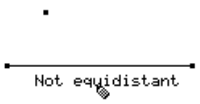
The **Equidistant** tool evaluates any three points to determine whether or not the first point is equidistant from the two remaining points.

1. Construct a point and a segment as shown.

2. Press
   TI-89: 2nd F6
   TI-92 Plus / Voyage™ 200 PLT: F6, select 8:Check Property, and then select 5:Equidistant.
3. Select the point (point to it and press ENTER).



4. Point to each of the segment's endpoints, pressing ENTER each time.
5. If desired, move the empty text box to an easy-to-read location.
6. Press ENTER to display the property in the text box.



As with the **Member** tool, simply dragging the point so that it appears to be equidistant may not change the displayed property. To position the point so that it is equidistant mathematically, you can create a perpendicular bisector for the segment. Then use **Redefine Object** in the F4 **Construction** toolbar menu to position the point on the perpendicular bisector.

Putting Objects in Motion

The **Display** toolbar menu contains the tools that let you animate and trace objects.

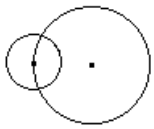
Animating Independent Objects

The **Animation** tool automatically moves an independent object along a specified path.

- If the **Pointer** tool is visible in the toolbar and the object does not lie on a defined path, the animated direction is 180 degrees from the spring. Otherwise, the object is animated along its defined path.
- If the **Rotate**, **Dilate**, or **Rotate & Dilate** tool is visible in the **Pointer** toolbox and the object can be transformed, the animation will be relative to the visible **Pointer** tool. For example, if the **Rotate** tool is visible, the object is rotated automatically.
- Pressing [ENTER] pauses the animation; pressing [ENTER] again resumes the animation. Pressing [ESC] or [ON] cancels the animation.

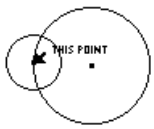
To animate an object:

1. Construct two circles as shown in this example.

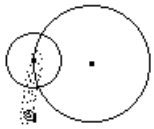


2. Press
   TI-89: [2nd][F7]
   TI-92 Plus / Voyage™ 200 PLT: [F7]
   and select 3:Animation.
3. Select the point of the object to animate.

Select the point.



Drag the animation spring.



4. Drag the animation spring in the opposite direction of the intended animation then release
   TI-89: [alpha]
   TI-92 Plus / Voyage 200 PLT: [⎋].
   —or—
   Press and release
   TI-89: [alpha]
   TI-92 Plus / Voyage 200 PLT: [⎋]
   twice quickly.

   The small circle moves around the circumference of the large circle.
5. Press [ESC] to stop the animation.

Note: *The farther away the spring is pulled, the faster the object is animated. You can also increase or decrease the animation while the object is in motion by pressing [+] or [−], respectively.*

Tracing the Path of an Object

The **Trace On/Off** tool traces the path of an object as it is moved.

- You can trace objects manually by dragging them, or automatically by using the **Animate** tool.
- You can select multiple objects for tracing, or deselect all trace objects, by pressing [↑][ENTER] with the cursor in an unoccupied location in the plane.
- You can clear the results of a trace by pressing [CLEAR].

To trace the path of a moving object:

1. Create a circle as shown in this example.

2. Press
   TI-89: [2nd][F7]
   TI-92 Plus / Voyage™ 200 PLT: [F7]
   and select 2:Trace On / Off.

3. Select the objects to trace.

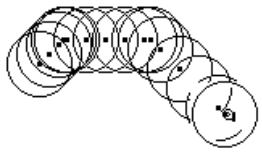
   Select any object or objects.

   Selected objects are displayed in a marquee outline.

Note: *The* Trace On / Off *tool works as a toggle function on an object.*

4. To disable the trace on an object, press
   TI-89: [2nd][F7]
   TI-92 Plus / Voyage 200 PLT: [F7]
   and select 2:Trace On / Off. Then select the object displayed in marquee outline.

Move the object to show the trace.



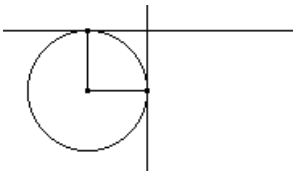
Controlling How Objects Are Displayed

The **Display** toolbar menu contains tools for controlling the display features of objects. The **File** toolbar menu contains several tools that determine how objects are viewed.

Hiding and Showing Objects

The **Hide/Show** tool in the **Display** toolbar menu hides selected visible objects and shows selected hidden objects. Hidden objects do not alter their geometric role in the construction.

1. Construct several objects such as those shown in this example.

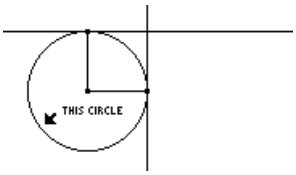


2. Press
   TI-89: 2nd F7
   TI-92 Plus / Voyage™ 200 PLT: F7
   and select 1:Hide / Show.

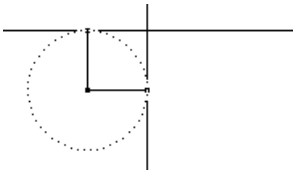
Note: *Hidden objects are shown in dotted outline when the* Hide / Show *tool is active.*

3. Point to each object that you want to hide and press ENTER.

Select the objects.



Selected objects are hidden.

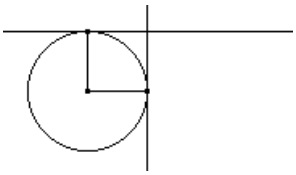


Note: *When the* Hide / Show *tool is active, pressing* ↑ *and* ENTER *at the same time in free space makes all hidden objects visible.*

4. Select a hidden object to make it visible again.

   The **Hide / Show** tool works as a toggle function on an object.

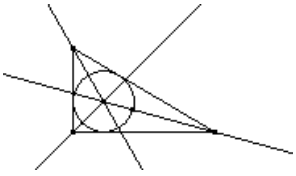
Hidden objects are displayed.



Changing the Line Thickness of Objects

The **Thick** tool in the **Display** toolbar menu changes the outline thickness of an object between Normal (one pixel) and Thick (three pixels) outlines.

1. Construct several objects such as those shown in this example.

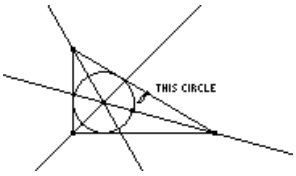


2. Press
   TI-89: 2nd F7
   TI-92 Plus / Voyage 200 PLT: F7
   and select 8:Thick.

Tip: Change the thickness of a point to set it apart from other points.

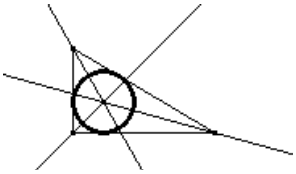
3. Point to the object to be outlined in thick outline.

Select the object.



Note: This option works as a toggle. Reselecting the object changes the outline back to normal.

4. Press ENTER to change the outline as shown then press ENTER again to change it back to normal.

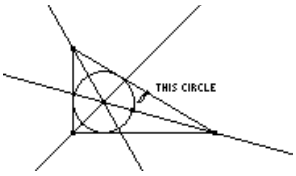


Changing the Line Pattern of Objects

The **Dotted** tool in the **Display** toolbar menu changes the outline pattern of objects between solid and dotted outlines.

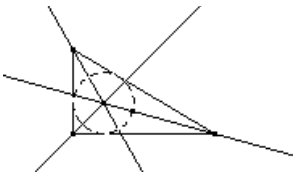
1. Press
   TI-89: 2nd F7
   TI-92 Plus / Voyage™ 200 PLT: F7
   and select 9:Dotted.
2. Point to a solid outlined object that is to be displayed in dotted outline.

Select the object.



Note: This option works as a toggle. Reselecting the object changes the outline pattern back to normal.

3. Press ENTER to change the outline as shown then press ENTER again to change it back to normal.

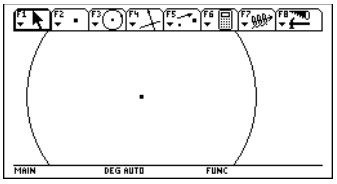


Showing the Entire Drawing Page

The **Show Page** command in the **File** toolbar menu allows you to view an entire construction, which can be larger than the drawing window. It displays the full-page picture of the construction in miniature.

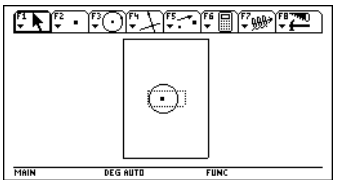
1. Construct a circle that is larger than the drawing window.
2. Press
   TI-89: 2nd F8
   TI-92 Plus / Voyage 200 PLT: F8
   and select A:Show Page.
3. Drag the small window to move the drawing view to a new location.

Normal view.



4. Press ENTER to accept the change or ESC to cancel and return to the normal drawing window.

Show Page view.



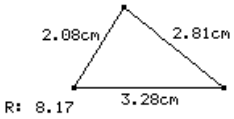
Viewing Data and Objects at the Same Time

Note: *When you select Data View, the construction is in the left screen, and the Data Matrix Editor is in the right screen. The Data/Matrix Editor stores collected data in the variable* sysData. *If you have not collected data,* sysData *may be empty and no data will be displayed.*

The **Data View** command in the **File** toolbar menu displays a split screen for viewing a geometry construction and collected data in the Data/Matrix Editor at the same time.

1. Construct and measure an object.

Construct and measure.

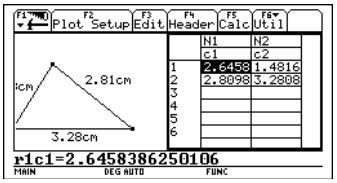


2. Press
   TI-89: 2nd F6
   TI-92 Plus / Voyage™ 200 PLT: F6
   select 7:Collect Data, and then select 2:Define Entry.

Define and store the data.

3. Select each data item that you want to define.
4. Press
   TI-89: 2nd F6
   TI-92 Plus / Voyage 200 PLT: F6
   select 7:Collect Data, then select 1:Store Data.
5. Press
   TI-89: 2nd F8
   TI-92 Plus / Voyage 200 PLT: F8
   and select B:Data View.

Display the object and its data.



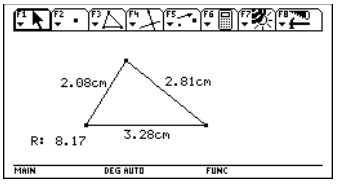
6. Press 2nd [⊡] (2nd function of the APPS key) to display the Data/Matrix Editor and the stored data and to switch between the two applications.

Clearing Data View

The **Clear Data View** command in the **File** toolbar menu brings you back to full-screen mode.

1. Press
   TI-89: 2nd F8
   TI-92 Plus / Voyage 200 PLT: F8
   and select C:Clear Data View.

Full-screen mode.



Adding Descriptive Information to Objects

The **Display** toolbar menu contains the tools that let you annotate your constructions.

Creating a Label Using the Label Tool

The **Label** tool attaches a label to a point, line, or circle. When you select an object with the **Label** tool, an edit box appears in which you can enter the label text or numbers.

- The label is a textual object that you can move anywhere within a specified distance from the object. The relative position of the label is maintained.
- To edit an existing label, place the cursor on the label, and press [ENTER]. A text cursor appears that allows you to edit the text in the label.
- To control the text cursor, press [♦] and the cursor pad simultaneously.
- All label text is horizontally oriented.

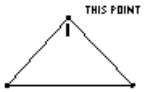
__Note:__ You also can attach a label to a point immediately after it is created by entering text from the keyboard.

To label an object:

1. Construct any object, such as the triangle shown in this example.

2. Press
   TI-89: [2nd][F7]
   TI-92 Plus / Voyage™ 200 PLT: [F7]
   and select 4:Label.
3. Select a point, line, or circle.

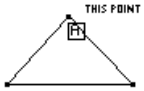
Select a point, line, or circle.



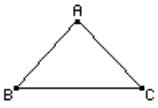
__Note:__ You can reposition the label by selecting it and then dragging it to the desired location.

4. Type the label text on the keyboard and press [ESC].

Enter a label.



Reposition and complete the labels.



Creating a Descriptive Comment

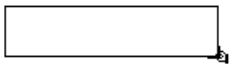
The **Comment** tool creates a text box in unoccupied space or next to a measurement. It is similar to the **Label** tool except that a comment text box does not attach itself to an object.

1. Press
   TI-89: 2nd F7
   TI-92 Plus / Voyage™ 200 PLT: F7
   and select 5:Comment.

Note: *The text cursor is controlled by pressing ♦ and the cursor pad simultaneously.*

2. Press ENTER to create a comment box anywhere in the plane. Drag the comment box by the lower right corner to specify the size of the comment.

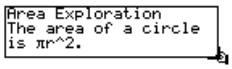
Drag an appropriately sized box.



Hint: *Use the* Comment *tool to add a descriptive label/comment to a measurement.*

3. Type the comment text on the keyboard and press ESC.

Enter a comment.



You can reposition the comment by dragging it to the desired location.

Creating and Editing Numerical Values

The **Numerical Edit** tool creates an edit box for editing numerical values, including interactive numbers or measurements. Interactive numbers must be created with this tool; and they can be interactively modified and used to define rotations, dilations, or measurement transfer values.

1. Press
   TI-89: 2nd F7
   TI-92 Plus / Voyage 200 PLT: F7
   and select 6:Numerical Edit.

Note: *The text cursor is controlled by pressing ♦ and the cursor pad simultaneously.*

2. Press ENTER to place an edit box anywhere in the drawing for creating an interactive number.

Position the edit box.

3. Type a numerical value and press ESC.

Enter a numerical value.

4. *(Optional)* Before pressing ESC, to add a unit description to a number, press: **TI-89:** 2nd F7 A:Units
   TI-92 Plus / Voyage 200 PLT:
   F7 A:Units
   and select from: Number, Length, Area, Volume, Angle.

Assign a unit of measurement.

Moving and Modifying a Number

You can move a number by selecting it and dragging it anywhere in the plane with the **Pointer** tool. You can modify a number when the edit box is active.

1. Select the number that you want to change.

Select a number to modify.

Note: *The I cursor is placed at the right of the least-significant digit.*

2. Press ← to delete the necessary digits then re-type the corrected number.

Edit the number with delete and replace.

Tip: *Point to a label, comment, or numerical edit value and press* ENTER *twice to open the appropriate tool automatically.*

3. Press ♦ ↑ or ♦ ↓ to increase or decrease the digit to the left or right of the cursor, respectively.

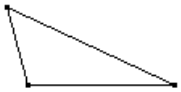
Edit the number with ♦ ↑.

4. Press ESC when finished.

Creating a Marked Angle

The **Mark Angle** tool labels an angle specified by three points with an angle mark.

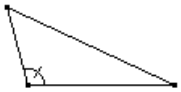
1. Create a triangle as shown in this example.



2. Press
TI-89: 2nd F7
TI-92 Plus / Voyage™ 200 PLT: F7
and select 7:Mark Angle.

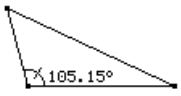
3. Specify the angle by selecting three points. The second point that you select becomes the vertex.

Select three points.



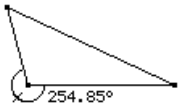
4. Press
TI-89: 2nd F6
TI-92 Plus / Voyage 200 PLT: F6
and select 3:Angle then select the marked angle.

Measure a marked angle.



5. To measure the exterior angle, drag the angle mark through the vertex of the angle.

Measure the exterior angle.



Creating Macros

The **Construction** toolbar menu contains the tools for constructing macros.

Introduction to Creating Macros

The **Macro Construction** menu item contains the tools for constructing macros in the Geometry application. A macro is a sequence of interdependent constructions. Macros are useful for creating new tools that construct unique objects or perform repetitive tasks.

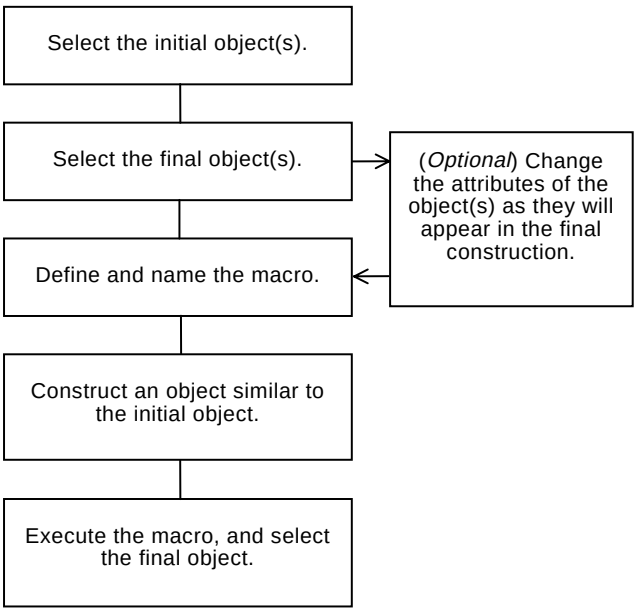
A macro constructs "final" objects based on "initial" objects. Intermediate objects are not constructed. This feature allows for easy construction of complex figures and is the primary method for constructing fractals. You can save macros for later use. Macros are saved automatically with any construction in which they are used. The number of objects created by a macro is limited only by available system memory.

Rules for Creating Macros

Rule	Explanation
• Initial objects must allow for the construction of all final objects.	Final objects are determined by the initial objects. A macro must respect the logical structure of the figure as it was constructed.
• An object cannot exist without the points that define it.	For example, a triangle cannot exist without its vertices. Therefore, when you select an object as an initial object, the macro is able to refer to the points that define the object.
• When you select Define Macro, a macro generates its final objects with the object's existing attributes.	You can change these attributes during an intermediate step before you select Define Macro. In this way, you can hide objects (using Hide/Show in the **Display** menu that were selected as initial objects.
• Comments and labels cannot be defined as final objects.	Macros are intended as general purpose construction tools, like those in the **Construction** menu. You can select measurements and numerical values as final objects, but any text attached will not be duplicated when the macro executes.
• The location of an arbitrary point on an object is determined by random-number generation.	The position of the point will be uncertain if it is selected as a final object and may result in an incorrectly defined macro.
• The order that initial objects are used depends upon the similarity of their types.	For example, lines and circles are different types, and they are not used in any order. When they are the same type, the macro uses them in the order in which they were selected as initial objects.

Overview: Creating and Executing a Macro

The flowchart below shows an overview of the basic steps required to create macros.



The **Execute Macro** command displays a pop-up menu that lists all defined macros. If the initial conditions of the selected macro are satisfied, the macro executes and generates the final object or objects.

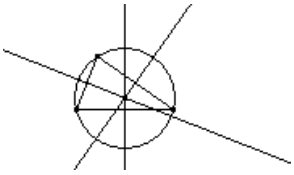
Example: Creating and Executing a Macro

To create and execute a macro:

1. Construct the initial and final objects.

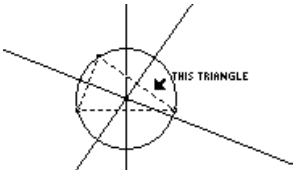
   For example, construct a triangle (initial object) and its perpendicular bisectors then construct a circle (final object) through all vertices of the triangle.

Construct the objects.



2. Press F4 and select 6:Macro Construction.
3. Select 2:Initial Objects then select the triangle as the initial object.

Select the initial object.

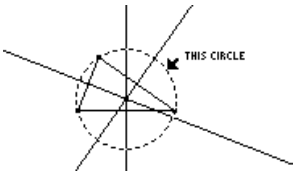


Example: Creating and Executing a Macro (Continued)

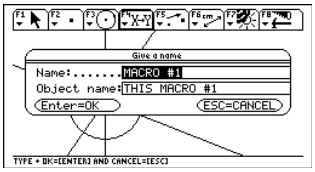
4. Press F4 and select 6:Macro Construction.
5. Select 3:Final Objects then select the circle as the final object.
6. (Optional) You can change the appearance of your construction by using the **Hide/Show**, **Thick**, and **Dotted** tools in the **Display** toolbar menu.
7. Press F4 and select 6:Macro Construction.
8. Select 4:Define Macro then type a name for the macro.

   The Name you enter will help you identify the macro later. The Object name you enter will appear in cursor messages when appropriate. Both names can be up to 25 characters.

Select the final object.



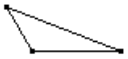
Name the macro.



Note: After the Name Macro dialog has been completed, the Save Macro dialog displays. You must provide a valid name to save your macro as a separate file. If you do not want to save the macro to a separate file, the macro is saved with your construction. In this case, you will not be able to open the macro from the **File** toolbar menu.

9. Construct the initial object (any triangle).

Construct an object.



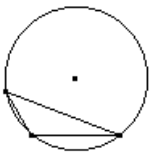
10. Press F4 and select 6:Macro Construction then select 1:Execute Macro.

Select the object.

11. Select the macro that you previously defined then select the triangle to execute the macro.

   This macro determines the center and radius of the circle and constructs a circle thorough all vertices of the triangle.

Execute the macro.



Note: *Defined macros appear in a pop-up menu. Highlight the desired macro, and press ENTER to select it.*

Geometry Toolbar Menu Items

This section shows the geometry toolbar and the subsequent Tool/Command menu items that are opened when you press one of the function keys.

Pointer Toolbar Menu

The F1 **Pointer** toolbar menu contains tools for selecting and performing freehand transformations.

F1

1:Pointer	see page 17
2:Rotate	see page 38
3:Dilate	see page 40
4:Rotate & Dilate	see page 42

Points and Lines Toolbar Menu

The F2 **Points and Lines** toolbar menu contains tools for constructing points or linear objects.

F2

1:Point	see page 19
2:Point on Object	see page 20
3:Intersection Point	see page 20
4:Line	see page 21
5:Segment	see page 21
6:Ray	see page 22
7:Vector	see page 22

Curves and Polygons Toolbar Menu

The F3 **Curves and Polygons** toolbar menu contains tools for constructing circles, arcs, triangles, and polygons.

F3

1:Circle	see page 24
2:Arc	see page 25
3:Triangle	see page 26
4:Polygon	see page 27
5:Regular Polygon	see page 28

Construction Toolbar Menu

The F4 **Construction** toolbar menu contains Euclidean geometry construction tools as well as a **Macro Construction** tool for creating new tools.

F4

1:Perpendicular Line	see page 29
2:Parallel Line	see page 30
3:Midpoint	see page 32
4:Perpendicular Bisector	see page 31
5:Angle Bisector	see page 31
6:Macro Construction ▶	see page 63
7:Vector Sum	see page 23
8:Compass	see page 24
9:Measurement Transfer	see page 33
A:Locus	see page 35
B:Redefine Object	see page 36

Geometry Toolbar Menu Items (continued)

Transformations Menu

The F5 **Transformations** toolbar menu contains tools for transformational geometry.

F5	
1:Translation	see page 37
2:Rotation	see page 39
3:Dilation	see page 41
4:Reflection	see page 43
5:Symmetry	see page 44
6:Inverse	see page 45

Measurement Menu

The **F6 Measurement** toolbar menu contains tools for performing measurements and calculations.

F6	
1:Distance & Length	see page 46
2:Area	see page 46
3:Angle	see page 47
4:Slope	see page 47
5:Equation & Coordinates	see page 48
6:Calculate	see page 49
7:Collect Data ▶	see page 50
B:Check Property ▶	see page 51

Display Menu

The **F7 Display** toolbar menu contains tools for annotating constructions or animating objects.

F7	
1:Hide / Show	see page 57
2:Trace On / Off	see page 56
3:Animation	see page 55
4:Label	see page 60
5:Comment	see page 61
6:Numerical Edit	see page 61
7:Mark Angle	see page 62
8:Thick	see page 57
9:Dotted	see page 58
A:Units	see page 61

File Menu

The **F8 File** toolbar menu contains file operations and editing functions.

F8		
1:Open...	♦O	see page 12
2:Save as...	♦S	see page 12
3:New...	♦N	see page 12
4:Cut		see Note
5:Copy		see Note
6:Paste		see Note
7:Delete	←	see page 18
8:Clear All		see page 18
9:Format...	♦F	see page 14
A:Show Page		see page 58
B:Data View		see page 59
C:Clear Data View		see page 59
D:Undo	♦Z	see page 11

Note: *Cut, copy, and paste are not available in the Geometry application.*

Note: *Some shortcut keys do not appear on the* TI-89.

Pointing Indicators and Terms Used in Cabri Geometry

This section describes the various pointing indicators that are used in the procedures and a glossary of terms

Pointers That Guide You

Several types of pointers exist to help guide you through your constructions. The pointers are shown and described below.

Cursor Display/Name	Active when...
arrow	The pointer is on an object.
+ cross hair	A Pointer indicator is selected or the cursor is in motion.
construction pencil	A construction tool is active.
selection pencil	A construction tool is active and a point can be placed on an object.
TI-89: alpha **TI-92 Plus / Voyage™ 200 PLT:**	A selected object can be moved.
open hand	On the TI-92 Plus, press 2nd and the cursor pad (↑, ↗, →, ↘, ↓, ↙, ←, ↖) at the same time to scroll the display anywhere within the plane. On the TI-89 / Voyage™ 200 PLT, press any two adjacent cursor keys to move diagonally.
I-beam	Text or numbers can be entered or edited in a label or comment box.
crossed lines	The comment box is active.
paint brush	Thick or dotted lines are selected.

Glossary of Geometry Definitions

The following terms are used in this chapter to describe specific Cabri Geometry II operations.

ENTER	Press any of the three ENTER keys on the TI-89 / TI-92 Plus / Voyage 200 PLT or the one ENTER key on the to execute a command or to confirm an action.
drag	Drag means to point to the object that you want to move, press and hold (drag key) on the TI-92 Plus / Voyage 200 PLT or the alpha key on the TI-89 to select the object, then move the screen pointer to a new location. Release alpha or to stop dragging.
marquee outline	A marquee outline shows the outline of an object using animated dots instead of a solid line.
page/plane	The page is a virtual working area of the plane.
point	When used as an instruction, point means to place the screen pointer on the object you want to select.
select	When used as an instruction, select means pointing to an object and pressing ENTER.

Helpful Shortcuts

Use the suggestions in the following table to quickly access or perform specific geometry functions.

Press ♦ ON.	• To turn off the TI-89 / TI-92 Plus / Voyage™ 200 PLT without exiting Geometry.
Press ♦ Z.	• To undo the last completed operation.
Press ESC.	• To return to the **Pointer** tool from anywhere.
Select an object and press + or −.	• To increase or decrease the displayed precision of selected numerical values. • To increase or decrease the number of objects in a selected locus. • To increase or decrease the animation speed.
Press ↑.	• To limit the slope of lines, rays, segments, vectors, triangles, or polygons to increments of 15 degrees when creating these objects. • To select multiple objects.
Press **TI-89:** alpha **TI-92 Plus / Voyage 200 PLT:** ⎋ once.	• To display all basic points (those points that you can drag) as flashing points. The cursor must be in unoccupied space.
Press **TI-89:** alpha **TI-92 Plus / Voyage 200 PLT:** ⎋ twice.	• To begin animation of an object. The **Animation** tool must be selected and the cursor pointing to the object.
Press ENTER once.	• To deselect selected objects. The pointer must be in unoccupied space.
Press ENTER twice.	• On the final point of a polygon, to complete construction of the polygon. • On a label, comment, or numerical value to invoke the appropriate editor.
Press ↑ and ENTER.	• To deselect all hidden or traced objects. The appropriate tool must be selected and the cursor must be in unoccupied space.
Press ♦ and the cursor key.	• To edit or change numerical values, comments, or labels.
Begin typing immediately after:	• Creating a point, line, or circle to add a label to an object. The label is limited to five characters and can only be edited with the **Label** tool. • Creating a measurement to add a comment to the measurement.

Helpful Shortcuts (continued)

Press **TI-89:** [↑] [alpha] **TI-92 Plus / Voyage 200™ PLT:** [2nd] [CAPS]	• To label vertices while drawing. • **Note:** [2nd] [alpha] is not available on the TI-89.
Press **TI-89:** [alpha] [alpha] **TI-92 Plus / Voyage 200 PLT:** [2nd] [LOCK]	• To lock drag mode when moving objects.

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