

TI-73 Geoboard

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Important Information

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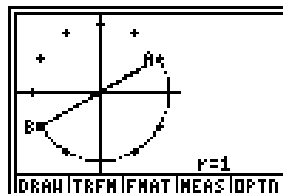
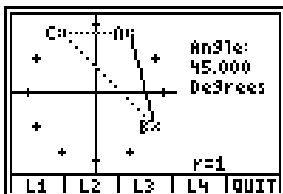
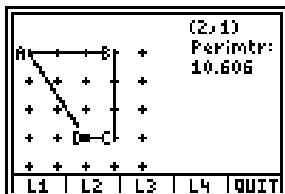
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What is Geoboard?

Geoboard is a Flash software application for the Texas Instruments TI-73 graphing calculator. It gives you an electronic geoboard on which you can form geometric objects. You can then manipulate and examine the objects.



You can:

- Draw objects on square or circular boards.
- Rotate, reflect, and translate objects.
- Measure lengths, areas, perimeters, and angles.
- Store measured values in TI-73 lists for plotting and analysis.
- Show or hide labels, axes, and coordinates.
- Save Geoboards so you can retrieve them later.

What You Will Need

To install and run TI-73 Geoboard, you need:

- A TI-73 with version 1.3007 or later of the Graph Explorer software. (To check the version, press **[2nd] [MEM]**, and select **About**.) To download a free copy of the latest Graph Explorer software, point your web browser to <http://education.ti.com/>
- At least 1000 bytes of available TI-73 RAM memory and:
 - An additional 97 bytes for each board that you save.
 - An additional 9 bytes for each measured value that you store in a list.

Geoboard notifies you if you try to save any data after available memory has dropped below 1000 bytes.

- A PC running Microsoft® Windows®, or an Apple® Macintosh®.
- The most recent version of TI-GRAPH LINK™ software for the TI-73. To download a free copy of this software, point your web browser to <http://education.ti.com/>

Where to Find Installation Instructions

You can find detailed instructions on installing Flash applications at this web site:

<http://education.ti.com/>

Getting Help

If you need help using the calculator, the TI-73 guidebook is available free as a PDF file at:

<http://education.ti.com/>

Getting Started

After installing TI-73 Geoboard on your calculator, you can work through this exercise to become familiar with the basic features of the Geoboard application.

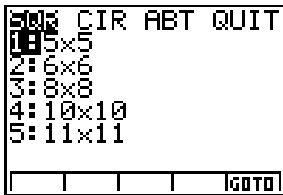
In the exercise, you create an irregular four-sided polygon and use Geoboard commands to measure the polygon's perimeter and one of its angles.

Starting with a Square Board

1. Turn the calculator on, and press the **[APPS]** key. The calculator displays a menu of installed applications.
2. Press the number key shown next to **Geoboard**, or highlight **Geoboard** with **▲** and **▼** and then press the **[ENTER]** key. The Geoboard startup screen appears.

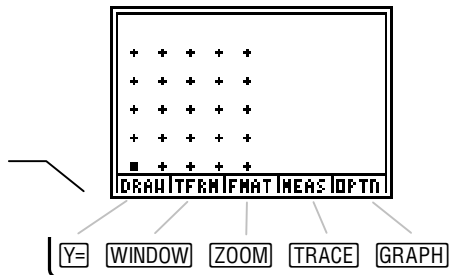


- Press any key to proceed. The Geoboard menu appears, showing choices for a square board. By default, the **5x5** option is highlighted.



- Press the **ENTER** key to select **5x5**. The 5x5 board appears with a small cursor at the lower-left peg and five commands along the bottom.

The Geoboard commands are mapped to the five TI-73 graphing keys.



DRAW = Draw object
TFRM = Transform
FMAT = Format
MEAS = Measure
OPTN = Options

Showing Coordinates and Vertex Labels

1. Select **FMAT** (press the **ZOOM** key). The **FORMAT** menu appears.
2. Press **◀**, **▶**, **▼**, and **▲** as necessary to highlight **LblsOn**, and then press the **ENTER** key.
3. Press **◀**, **▶**, **▼**, and **▲** as necessary to highlight **CoordOn**, and then press the **ENTER** key.
4. Select **QUIT**. The board reappears. The cursor coordinates are shown, and the vertices of objects that you draw will have alphabetic labels.

Note

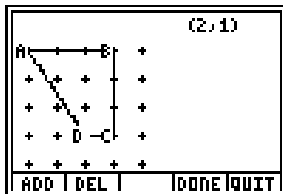
Geoboard creates unique labels for the vertex points of each object. Even if vertex points of different objects share a common peg, each vertex point has its own label.

Drawing the Object

A Geoboard object can be a line segment or a closed polygon. You can create as many as six objects on a board, provided you do not exceed a maximum of 26 total vertices per board.

1. Select **DRAW** (press the $\boxed{Y=}$ key). The commands change to drawing commands, **ADD**, **DEL**, **DONE**, and **QUIT**.
2. Press $\boxed{\blacktriangle}$ repeatedly to move the cursor to the top row.
3. Select **ADD** to add a point at the cursor position.
4. Press $\boxed{\blacktriangleright}$ $\boxed{\blacktriangleright}$ $\boxed{\blacktriangleright}$. As the cursor moves, it leaves a dotted line to show the new portions of the object that you are drawing.
5. Select **ADD** to add a second point. The dotted line becomes solid.
6. Press $\boxed{\blacktriangledown}$ $\boxed{\blacktriangledown}$ $\boxed{\blacktriangledown}$, and then select **ADD** to add a third point. You now have a triangle.
7. Press $\boxed{\blacktriangleleft}$, and then select **ADD** to add a fourth point.

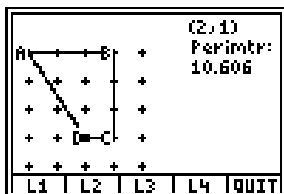
8. Select **DONE**. Your four-sided object looks like this:



9. Select **QUIT**. The main Geoboard commands reappear.

Measuring and Storing the Perimeter

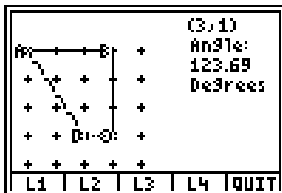
1. Select **MEAS** (press the **TRACE** key). The MEASUREMENT menu appears.
2. Select **Perimeter**. The board reappears, with the **Perimtr** prompt.
3. If the cursor is not already on one of the object's defined vertices, use the arrow keys to move the cursor to a defined vertex.
4. Press the **ENTER** key. The object's perimeter, **10.606**, appears, and the Geoboard commands change to let you store the measured value.



5. Select **L1** to store the value in the calculator's **L1** list. The main Geoboard commands reappear.

Measuring and Storing Angle ADC

1. Select **MEAS** (press the **TRACE** key), and then select **Angle**. The board reappears, with the **Angle** prompt.
2. Move the cursor to point **A**, and then press the **ENTER** key. The point is marked with an **x**.
3. Move the cursor to point **D**, and then press the **ENTER** key. The point is marked with an **x**.
4. Move the cursor to point **C**, and then press the **ENTER** key. The angle, **123.69**, appears, and the angle is shown as a dotted line on the object.



5. Select **L2** to store the value in the calculator's **L2** list. The main Geoboard commands reappear.

Quitting the Geoboard Application

Quitting the application or turning off the calculator does not remove Geoboard from the Flash memory. To remove it, refer to [Removing Geoboard](#).

1. Press **2nd** [QUIT]. The message **Exit this board?** appears.
2. Select **YES**. If you have made changes that you have not saved, the message **Save this board?** appears.
 - Select **YES** if you want to save the board. Follow the prompts to select a name for the board.
 - Select **NO** if you want to quit without saving.
3. When the main Geoboard menu appears, press **▶ ▶ ▶** to display the QUIT menu.
4. Select **YES**. The TI-73 home screen appears.

Inspecting the Stored Values

1. After quitting the Geoboard application, press the **[LIST]** key. The perimeter and angle that you stored appear in **L1** and **L2**. If you had values stored in these lists prior to running Geoboard, the Geoboard values will be the last ones.

L1	L2	L3	1
100.6069	123.69	-----	
-----	-----		
L1()=10.60555127...			

2. Press **[2nd]** **[QUIT]** to return to the home screen.

Where to Go from Here

Now that you have the basic skills for using the TI-73 Geoboard, you can explore its remaining features.

Use the links on the [first page](#) to learn how to:

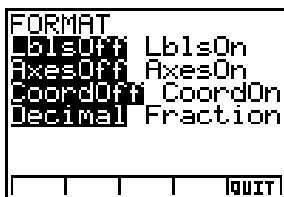
- Perform other tasks, such as transforming objects.
- Work through specific examples.
- Find other troubleshooting and customer-support information.

Working with Boards

Choosing Format Settings

When you are viewing a board, you can use the **FMAT** command to show or hide labels, axes, and coordinates. You can also choose whether measured results are displayed as fractions or decimal numbers. These Geoboard settings do not affect the calculator's **FORMAT** settings.

1. While viewing a board, select **FMAT** (press the **ZOOM** key). The **FORMAT** menu appears.



- Hide or show vertex labels
- Hide or show the axes
- Hide or show cursor coordinates
- Show measured results as decimals or fractions

2. To change any format setting, press **◀**, **▶**, **▼**, and **▲** as necessary to highlight the setting, and then press the **ENTER** key.
3. When you have finished setting the formats, select **QUIT**. The board reappears with your new settings in effect.

Erasing a Board

1. While viewing the board, select **OPTN** (press the **GRAPH** key). The **OPTIONS** menu appears.
2. Select **Erase Board**. The confirmation message **Erase board?** appears.
3. Select **YES**. The board reappears, with all objects erased. On square boards, the origin is set to the lower-left corner.

Moving the Origin on a Square Board

1. While viewing the board, select **OPTN** (press the **GRAPH** key). The **OPTIONS** menu appears.
2. Select **Move Origin**. The board reappears, with x and y axes.
3. Use the cursor keys (**▲**, **▼**, **◀**, and **▶**) to reposition the origin.
4. Press the **ENTER** key. The main Geoboard commands reappear.

Note

To cancel moving the origin before you have pressed **ENTER**, select **QUIT**.

5. If you want to remove the axes, select **FMAT**, select **AxesOff**, and press the **ENTER** key.

Creating a Circular Board

1. To exit the board you are viewing, select **OPTN** (press the **GRAPH** key), and then select **Main Menu**. The Message **Exit this board?** appears.
2. Select **YES**. If you have made changes that you have not saved, the message **Save this board?** appears.
 - Select **YES** to save the board. Follow the prompts to select a name for the board.
 - Select **NO** to exit without saving.
3. When the main Geoboard menu appears, press **◀** or **▶** as necessary to highlight the **CIR** menu item. Options appear for selecting the radius and the number of pegs, with the current settings highlighted.
4. Press **▼** to highlight the Radius options, press **◀** or **▶** to highlight a radius, and then press the **ENTER** key.
5. Press **▼** to highlight the Pegs options, press **◀** or **▶** to highlight the number of pegs, and then press the **ENTER** key.
6. Select **GOTO**. The circular board appears.

Moving the Cursor on a Circular Board

To move from the center to the outer pegs Press

To move to the center Press

To move clockwise around the pegs Press

To move counter-clockwise around the pegs Press

Redrawing a board

Press . All objects are redrawn.

Note

To ensure the fastest speed, Geoboard does not constantly redraw objects or parts of objects that have been erased temporarily during an operation (such as transforming or measuring). When you complete the operation, all objects on the board are redrawn.

Creating and Deleting Objects

A Geoboard object can be a line segment or a closed polygon. You can create as many as six objects on a board, provided you do not exceed a maximum of 26 total vertices per board.

Drawing an Object on a Square Board

1. Select **DRAW** (press the $\boxed{Y=}$ key). The commands change to square-board drawing commands, **ADD**, **DEL**, **DONE**, and **QUIT**.
2. Use the cursor keys ($\boxed{\blacktriangle}$, $\boxed{\blacktriangledown}$, $\boxed{\blacktriangleleft}$, and $\boxed{\blacktriangleright}$) to move the cursor to the object's first point.
3. Select **ADD** to add a point at the cursor position.

Note

If the word **Limit** appears, you have reached the maximum of 26 vertices. Select **Quit** to remove the message and complete the object. Select **Quit** again to restore the main Geoboard commands.

4. Move the cursor to the next point. As the cursor moves, it leaves a dotted line to show the new portions of the object.
5. Select **ADD** to add another point. The line becomes solid.

6. Continue adding points until the object is complete.
7. Select **DONE**. The object is shown with a solid line.
8. Select **QUIT**. The main Geoboard commands reappear.

Drawing an Object on a Circular Board

1. Select **DRAW** (press the $\boxed{Y=}$ key). The commands change to **ADD**, **DEL**, **DONE**, and **QUIT**.
2. Move the cursor to the object's first point, using the cursor keys as described in [Moving the Cursor on a Circular Board](#).
3. Select **ADD** to add a point at the cursor position. The point is added, and the **ARC** command appears so you can add a point that creates an arc instead of a chord.

Note

If the word **Limit** appears, you have reached the maximum of 26 vertices. Select **Quit** to remove the message and complete the object. Select **Quit** again to restore the main Geoboard commands.

4. Move the cursor to the next point. As the cursor moves, it leaves a dotted line to show the new portions of the object.

5. Select **ADD** to add another point. The dotted line becomes solid.

Note

If you want to create an arc instead of a chord, select **ARC** instead of **ADD**. The arc is always drawn in a clockwise direction. You cannot draw an arc to or from the center point.

6. Continue adding points until the object is complete.
7. Select **DONE**. The object is shown with a solid line.
8. Select **QUIT**. The main Geoboard commands reappear.

Deleting a Point While Drawing an Object

You can remove points on an object while drawing it, starting with the most recently added point.

1. While creating an object, select **DEL** (press the **WINDOW** key). The last point that you added is removed, and the object's outline is redrawn.
2. Resume adding points until you have completed the object.

Deleting an Object

1. Make sure you are not currently creating an object. You should see the main Geoboard commands (**DRAW**, **TFRM**, and so on).
2. Use the cursor keys (⬆️, ⬇️, ⬅️, and ➡️) to move the cursor to any vertex on the object that you want to remove.
3. Press the **DEL** key. The object is shown with a dotted line, and the message **Delete - Are You Sure?** appears.

Note

If you have selected a point that is shared by two or more objects, the message **Select Object** appears. Press ⬆️ as necessary to select the object that you want to remove.

4. Press the **ENTER** key to remove the object, or press any other key to keep the object. When you delete an object, its labels may be reassigned to remaining objects.

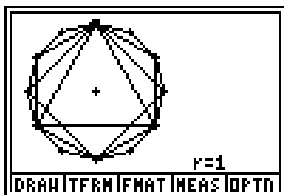
Example: Creating Regular Polygons

In this exercise, you examine factors by creating a circular board and populating it with regular (equilateral) polygons whose vertices are on the perimeter. The specific shapes that you can draw depend on the number of pegs around the board.

1. Create a 12-peg circular board with a radius of 1.
2. Select **F_{MAT}** (press the **ZOOM** key), and then select **LblsOff**.
3. Starting at the topmost peg, select **DRAW** and use the **ADD** command to place a vertex at every 4th peg. This creates a 3-sided regular polygon (an equilateral triangle). The triangle is possible because 4 and 3 are factors of 12. $4 \times 3 = 12$.
4. Starting again at the top peg, place a vertex at every 3rd peg to draw a 4-sided regular polygon (a square). $3 \times 4 = 12$.
5. Starting again at the top peg, place a vertex at every 2nd peg to draw a 6-sided regular polygon (a hexagon). $2 \times 6 = 12$.

6. Start once more at the top peg and draw a 12-sided regular polygon by placing a vertex at every peg. $12 \times 1 = 12$.

You now have one example of each regular polygon that can be drawn around a 12-peg board.



7. Make sure the cursor is on the top peg, and press the **ENTER** key. The first polygon becomes selected.
8. Press **▲** to view the polygons in succession.

Notice that for each polygon, the number of sides \times the number of pegs from vertex-to-vertex = 12. Consider the number of regular polygons possible on a 24-peg board.

Saving and Sharing Boards

Saving a Board

You can save the current board. A square board can be saved with the name **S1**, **S2**, or **S3**, and a circular board can be saved as **C1**, **C2**, or **C3**.

1. If necessary to complete any unfinished operation, select **QUIT**, or press the **CLEAR** key.
2. Select **OPTN** (press the **GRAPH** key). The **OPTIONS** menu appears.
3. Select **File Save**. The **Save** menu appears, showing the three possible names for the type of board.
4. Highlight a name, and then press the **ENTER** key to save the board. If you previously saved a board using that name, the message **Replace?** appears.
 - To replace the saved board, press the **ENTER** key, and then select **QUIT**.
 - To cancel saving the current board, select **QUIT**.

Opening a Saved Board

You can open any saved board that is the same type as the board you are viewing.

1. If you first want to save the current board, follow the steps for [Saving a Board](#).
2. Select **OPTN** (press the **GRAPH** key). The **OPTIONS** menu appears.
3. Select **File Open**. The **Open** menu appears, displaying the list of boards.

Note

If you are viewing a square board, only the square boards are listed. If you are viewing a circular board, only the circular boards are listed.






4. Select the board that you want to open. The opened board replaces the board that you were viewing.

Copying Saved Boards to Another Calculator


1. [Quit the Geoboard application.](#)
2. Connect the calculators by using a unit-to-unit cable.
3. On the *receiving* unit, start the Link application. On a TI-73, for example, press the **[APPS]** key, and then select **Link**. The SEND / RECEIVE menu appears.
4. Press **[▾]** to display the RECEIVE menu, and then press **[ENTER]**. The receiving unit displays the **Waiting** message.
5. On the *sending* unit, press **[APPS]**, and then select **Link**. The SEND / RECEIVE menu appears, showing a list of items that you can send.
6. Scroll to **AppVars**, and select it. The SELECT / TRANSMIT menu appears, showing the list of AppVars.

Note

The AppVar name of each board is the board's name with the letters "Geobd" appended. For example, the circular board **C1** has the AppVar name **C1Geobd**.

7. Mark each board that you want to send by using  and  to point to the board's name and then pressing .
8. Press  to highlight TRANSMIT, and then press . The marked boards are transmitted to the receiving unit.

When the transmission has completed, both calculators display the message **Done**.

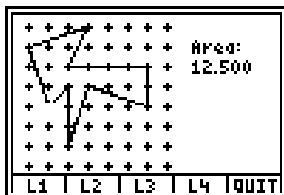
9. On each calculator, press  [QUIT] to exit the Link application.

Measuring Objects

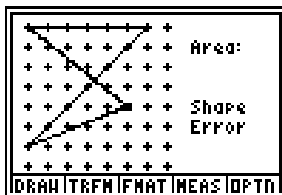
Valid Shapes for Area and Perimeter Measurements

Valid shapes for measuring areas and perimeters are shapes that have no intersecting lines and do not use the same peg more than once. The message **Shape Error** appears if you attempt to measure the area or perimeter of an invalid shape.

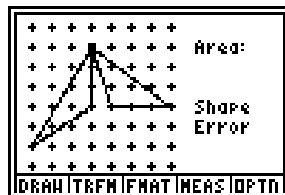
Valid shape



Invalid shape
(lines cross)



Invalid shape
(upper peg used twice)



Restrictions on Fraction Results

For lengths, areas, and perimeters, Geoboard gives decimal or fraction results, depending on the Decimal/Fraction format setting. Fraction measurements that are irrational (such as a hypotenuse that is $\sqrt{5}$) are approximated (56/25 in this case).

For angles, the results are always given in decimal degrees, regardless of the Decimal/Fraction setting. Also, if you measure an angle, the FRACTION format is changed to DECIMAL.

Clearing Lists before Storing Measured Values

When you take a measurement, the Geoboard application makes it easy for you to store the value in any of the TI-73 lists **L1** through **L4**. Before starting Geoboard, you might want to clear one or more of those lists so that they will contain only the Geoboard results.

1. [Quit the Geoboard application.](#)
2. Press the **[LIST]** key. The list editor appears.
3. Press **[◀]** and **[▶]** as necessary to select the list to be cleared.
4. Press **[▲]** to highlight the name of the selected list.
5. Press **[CLEAR]** **[ENTER]**. The selected list is cleared.

Note

When you store a measured value, Geoboard stores it in the first available space at the end of the list. If a list has been deleted, you can restore the standard lists **L1** through **L6**. Press **[2nd]** **[CATALOG]**, use **[▼]** to scroll down to the **SetUpEditor** command, and press **[ENTER]** **[ENTER]**.

Measuring the Length of a Line Segment

1. Select **MEAS** (press the **TRACE** key). The MEASUREMENT menu appears.
2. Select **Length**. The board reappears, with the **Length** prompt.
3. Use the cursor keys (**▲**, **▼**, **◀**, and **▶**) to move to either of the two points that form the line segment, and press the **ENTER** key.
4. Move the cursor to the other point, and press the **ENTER** key. The length value appears, and commands appear for storing the value in a list.

Note

If a value does not appear, you might have selected a peg that is not one of the object's vector points. Make sure you are measuring a line segment that was defined as part of the object.

5. Select the TI-73 list in which you want to store the value, or select **QUIT** to discard the value. The main Geoboard commands reappear.
6. Press **CLEAR** **CLEAR** to stop measuring.

Measuring an Object's Area

You can measure the area of any closed polygon that has no intersecting lines.

1. Select **MEAS** (press the **TRACE** key). The MEASUREMENT menu appears.
2. Select **Area**. The board reappears, with the **Area** prompt.
3. Use the cursor keys (**▲**, **▼**, **◀**, and **▶**) to move to any vertex on the object, and press the **ENTER** key. The area value appears.

Tip

If you have drawn multiple objects on the board, select a point that is unique to the object that you want to measure. If you select a shared point instead, you must use the **▲** key to select the object before pressing **ENTER**.

4. Select the TI-73 list in which you want to store the area value, or select **QUIT** to discard the value. The main Geoboard commands reappear.
5. Press **CLEAR** **CLEAR** to stop measuring.

Measuring an Object's Perimeter

You can measure the perimeter of any closed polygon that has no intersecting lines.

1. Select **MEAS** (press the **TRACE** key). The MEASUREMENT menu appears.
2. Select **Perimetr**. The board reappears, with the **Perimetr** prompt.
3. Use the cursor keys (**▲**, **▼**, **◀**, and **▶**) to move to any vertex on the object, and press the **ENTER** key. The perimeter appears.
4. Select the TI-73 list in which you want to store the perimeter value, or select **QUIT** to discard the value. The main Geoboard commands reappear.

Tip

If you have drawn multiple objects on the board, select a point that is unique to the object that you want to measure. If you select a shared point instead, you must use the **▶** key to select the object before pressing **ENTER**.

5. Press **CLEAR** **CLEAR** to stop measuring.

Measuring an Angle

1. Select **MEAS** (press the **TRACE** key). The MEASUREMENT menu appears.
2. Select **Angle**. The board reappears, with the **Angle** prompt.
3. Use the cursor keys (**▲**, **▼**, **◀**, and **▶**) to move to the first of the three points that form the angle, and press the **ENTER** key.
4. Move the cursor to the second point, and press the **ENTER** key.
5. Move the cursor to the third point, and press the **ENTER** key. The angle value appears, and the angle is shown as a dotted line on the object.
6. Select the TI-73 list in which you want to store the value, or select **QUIT** to discard the value. The main Geoboard commands reappear.
7. Press **CLEAR** **CLEAR** to stop measuring.

Note

Angle measurement always displays the smaller of the two angles formed by the two sides. The smaller angle might be the angle on the outside of the object rather than the angle on the inside.

Measuring the Length of an Arc

On a circular board, you can measure the length of any single arc that you have drawn. You must specify the same starting and ending points that you used to draw the arc. However, the starting point must not be shared by another object. The length is always measured clockwise from the starting point to the ending point.

Tip If you are uncertain of the arc's starting and ending points, you can use the **FMAT** command to display labels.

1. Select **MEAS** (press the **TRACE** key). The MEASUREMENT menu appears.
2. Select **Arc Length**. The board reappears, with the **Arc** prompt.
3. Use the **◀** and **▶** keys to move to the arc's starting point, and press the **ENTER** key.
4. Move the cursor to the arc's ending point, and press the **ENTER** key. The arc length value appears.
5. Select the TI-73 list in which you want to store the value, or select **QUIT** to discard the value. The main Geoboard commands reappear.

6. Press **CLEAR** **CLEAR** to stop measuring.

Example: Examining the Areas of Squares

This example uses Geoboard to demonstrate visually how a square's area is related to the length of the square's sides.

1. [Quit the Geoboard application](#), and then clear list **L1**. You will be using **L1** to store measured areas.
2. Restart Geoboard, and select the **8×8** square board.
3. If labels are on, select **FMAT** (press the **ZOOM** key), and then select **LblsOff**.
4. Using the **DRAW** command, draw a **1×1** square in the lower-left corner.
5. Use the **MEAS** command to measure the square's area, and store the value in **L1**.
6. Starting again in the lower-left corner, draw a **2×2** square, and count the number of small (**1×1**) squares in the **2×2** square. The count is 4 small squares.

7. Measure the area of the 2×2 square, compare it with your count, and store the area in L_1 .
8. Starting again in the lower-left corner, draw a 3×3 square, and count the number of small squares in this square. The count is 9 small squares.
9. Measure the area of the 3×3 square, and store the area in L_1 .
10. Draw one more large square in the corner. Make it 4×4 . Count the small squares in this square.
11. Measure the area of the 4×4 square, and store the value in L_1 .
12. [Quit the Geoboard application](#), and then press the $\boxed{\text{LIST}}$ key to examine the area values in list L_1 .

Consider the sequence of numbers of the stored areas. Is there a pattern to the sequence?

If there is a pattern, what would you expect the area of the entire 8×8 board to be? What about an $n \times n$ board?

Transforming Objects

Rotating an Object

On a square board, you can rotate an object clockwise or counter-clockwise around any of its vertices. On a circular board, you can rotate an object clockwise or counter-clockwise around the center peg.

1. Select **TFRM** (press the **WINDOW** key). The TRANSFORMATION menu appears.
2. Select **Rotate**. The board reappears, with the **Rotate** prompt.
3. Use the cursor keys (**▲**, **▼**, **◀**, and **▶**) to place the cursor on the vertex around which you want to rotate the object.
4. Press the **ENTER** key. A temporary copy of the object is displayed with dotted lines.

Note If you have selected a point that is shared by multiple objects, Geoboard selects the first object that used the point.

5. Use the **◀** and **▶** keys to rotate the temporary copy.

Note If the entire rotated object does not fit on the board, a **Limit** error message is displayed.

6. Select either **MOVE** (to rotate the original object to the new location) or **COPY** (to keep both the original object and the rotated copy).

Note A copy operation must not exceed Geoboard's maximum of 26 points or 6 objects per board. To cancel the rotation before you have selected **MOVE** or **COPY**, select **QUIT**. The temporary copy is erased.

Reflecting an Object

You can reflect an object along a horizontal or vertical line of reflection that you define. On a circular board, the line of reflection must intersect the center peg. Note that you cannot create a horizontal reflection line on the 6-peg circular board.

1. Select **TFRM** (press the **WINDOW** key). The TRANSFORMATION menu appears.
2. Select **Reflect**. The board reappears, with the **Reflect** prompt.
3. Use the cursor keys (**▲**, **▼**, **◀**, and **▶**) to place the cursor on one of the object's vertex points.

4. Press the **ENTER** key. A temporary copy of the object is displayed with dotted lines.

Note If you have selected a point that is shared by multiple objects, Geoboard selects the first object that used the point.

5. Place the cursor on one of two points that will form the line of reflection, and press the **ENTER** key to select the point.
6. Place the cursor on a second point that forms a horizontal or vertical line of reflection, and press the **ENTER** key. The temporary copy is reflected along the line.

Note If the entire reflected object does not fit on the board, the message **Limit** is displayed. If the line of reflection is not horizontal or vertical, the message **NoAxis** is displayed. Press **CLEAR** to cancel, and then restart the reflection.

7. Select either **MOVE** (to replace the original object with the reflected copy) or **COPY** (to keep both the original object and the reflected copy).

Note A copy operation must not exceed Geoboard's maximum of 26 points or 6 objects per board. To cancel the reflection before you have selected **MOVE** or **COPY**, select **QUIT**. The temporary copy is erased.

Translating an Object

When you translate an object, you have the option of moving either the original object or a copy of it. The operation must not exceed Geoboard's maximum of 26 points or 6 objects.

1. Select **TFRM** (press the **WINDOW** key). The TRANSFORMATION menu appears.
2. Select **Translate**. The board reappears, with the **Translate** prompt.
3. Use the cursor keys (**↑**, **↓**, **←**, and **→**) to place the cursor on one of the object's points.
4. Press the **ENTER** key. A temporary copy of the object is displayed with dotted lines.

Note If you have selected a point that is shared by multiple objects, Geoboard selects the first object that used the point.

5. Use the cursor keys (**↑**, **↓**, **←**, and **→**) to reposition the temporary copy.

6. Select either **MOVE** (to move the original object to the new location) or **COPY** (to keep both the original object and the copy).

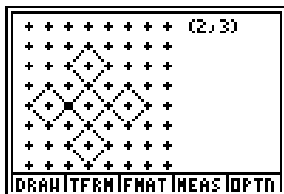
Note

A copy operation must not exceed Geoboard's maximum of 26 points or 6 objects per board. To cancel the translation before you have selected **MOVE** or **COPY**, select **QUIT**. The temporary copy is erased.

Example: Rotating Objects to Create a Pattern

1. Start with the **8×8** square board.
2. Select **FMAT** (press the **ZOOM** key), and then select **LblsOff** and **CoordOn**.
3. Create a diamond-shaped object with vertices at coordinates (3,4), (4,3), (3,2), and (2,3). This will serve as the base object for four rotations.
4. Starting at (3,4), rotate the base object 180° , and then select **COPY**. You now have a copy directly above the base object.
5. Make a second copy directly to the right of the base object by starting at (4,3) and rotating 180° .

6. Make a third copy directly below the base object by starting at (3,2) and rotating 180° .
7. Make a fourth copy directly to the left of the base object by starting at (2,3) and rotating 180° . You now have a pattern of five diamonds forming a cross.







Consider how you might use reflection to create the same pattern.

Consider how you might use rotation to fill in the empty spaces and form a large diamond.


Removing the Geoboard Application





Removing Geoboard makes Flash memory available for other applications.

1. [Quit the Geoboard application.](#)
2. Press  [MEM]. The MEMORY menu appears.
3. Select **Delete**, and then select **Apps**.
4. Use  or  to select **GEOBOARD**, and then press the  key. A message asks **Are You Sure?**
5. Select **YES**.

Removing Saved Boards

Removing saved boards creates more space for TI-73 lists, variables, and pictures.

1. [Quit the Geoboard application.](#)
2. Press  [MEM]. The MEMORY menu appears.
3. Select **Delete**, and then select **AppVars**.

4. For each AppVar containing the word **Geobd**, use  or  to select the AppVar, and then press the  key.
5. When you have finished removing the saved boards, press  [QUIT]. You are returned to the home screen.

Troubleshooting / Interpreting Messages

Geoboard Messages

Message	Description
Limit	Geoboard cannot perform the requested rotation, reflection, or translation because the transformed object does not fit on the board. Press [CLEAR] to cancel, and then restart the transformation.
MemErr	<p>You may have attempted to store a measured value to a list that is full. To empty the list, quit Geoboard and execute the ClrList instruction, available in the Stat > Ops menu.</p> <p>You may have attempted to store a value to a list that has been deleted. To create the list, quit Geoboard, press [2nd] [CATALOG], use [↓] to scroll down to the SetUpEditor command, and press [ENTER] [ENTER].</p> <p>You may have attempted to save a board or store a measured value after available RAM memory has dropped below 1000 bytes. Quit Geoboard and delete some items from memory.</p>
MEMORY LIMIT	You have attempted to run Geoboard with less than 1000 bytes of RAM memory available. Press any key to remove the message, and then delete some items from memory.

Message	Description
NoAxis	You have attempted to define a line of reflection that is not horizontal or vertical. Move the cursor to the line's first point, press [ENTER] to select it, move to a second point that forms a horizontal or vertical line, and press [ENTER] .
Not Found	You have attempted to use File Open to open a Geoboard file that does not yet contain a saved board.
Object Limit	The requested operation would exceed Geoboard's maximum of six objects on a board.
Object not found	You have pressed [ENTER] to perform an object operation without first moving the cursor to an object's vertex point. Try moving the cursor to a vertex point and pressing [ENTER] again.
Point Limit	The requested operation would exceed Geoboard's maximum of 26 total points on a board.
Replace?	You are saving a board to a name that already contains a previously saved board. To replace the saved board, press [ENTER] . To cancel the save, press any other key.

Message**Description**

Shape**Error**

You have attempted to measure the area or perimeter of an object:

- That is a line segment.
- That has intersecting lines.
- That uses the same peg more than once.

Press **CLEAR** to remove the message.

Installation Error Messages

Low Battery Condition — Do not attempt to install Geoboard if this message appears on the calculator's initial screen. If you receive this error during an installation, change the batteries before trying again.

Archive Full — This message appears when the TI-73 does not have sufficient memory to store the application. You must remove an application from the TI-73 in order to make room for the application.

You can create a backup of an application on your computer by using the **Link > Receive Flash Software** menu in the most recent version of TI-GRAPH LINK™ for the TI-73. Anytime after saving the application, you can reload it to the TI-73 using the **Link > Send Flash Software** menu in TI-GRAPH LINK.

Communication Error — This error indicates the installer is unable to communicate with the TI-73. The problem is usually associated with the TI-GRAPH LINK cable and its connection to the TI-73 and/or to the computer. Make sure the cable is firmly pushed in to the calculator and the computer.

If this does not correct the problem, try a different TI-GRAPH LINK cable and restart your computer. If you continue to receive this error, please contact [Customer Support](#) for assistance.

Flash Application Did Not Install — Follow the steps below to restart the installation.

1. If you selected **CANCEL** during the installation, skip to step 3.
2. If you disconnected the TI-GRAPH LINK cable from either the TI-73 or the computer, reconnect the cable prior to restarting the installation.

Within about 20 seconds after the installer is interrupted, an error message appears on your computer. The installer exits after you dismiss the error message, and the home screen appears.

3. Retry the installation procedure.

If you continue to have difficulty, contact Customer Support.

Validation Error — Either this calculator does not have a certificate to run the application, or electrical interference caused a link to fail. Try to install the application again. If you continue to receive this error, contact [Customer Support](#).

Checksum Error — The TI-GRAPH LINK software was not able to verify that the application was fully installed. Try to install the application again. If you continue to receive this error, contact Customer Support.

Other Calculator Errors — For information about other error messages, refer to the error messages in Appendix B of the TI-73 guidebook, or contact Customer Support.

Miscellaneous

Verify Maintenance Upgrade Version and Serial Number

1. Press **[2nd]** **[MEM]**.
2. Select **ABOUT**.
3. Identify the version number and serial number.
 - The version number has the format *x.yy*.
 - The serial number appears beneath the product ID number.

Check Amount of Flash Application Free Space

Geoboard requires one available application space. You might need to remove another application to make room for Geoboard.

1. Press **[2nd]** **[MEM]**.
2. Select **Check APPs**.
3. Note the number of **Spaces Free**.
4. If you have no spaces free, remove an application.

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