



### About the Lesson

Students will graph a figure in the coordinate plane. They will use list operations to perform reflections, rotations, translations, and dilations on the figure, and graph the resulting image using a scatter plot. As a result, students will:

- Perform reflections, rotations, translations, and dilations using lists and scatter plots to represent figures on a coordinate plane.

### Vocabulary

- rotation
- reflection
- translation
- dilation

### Teacher Preparation and Notes

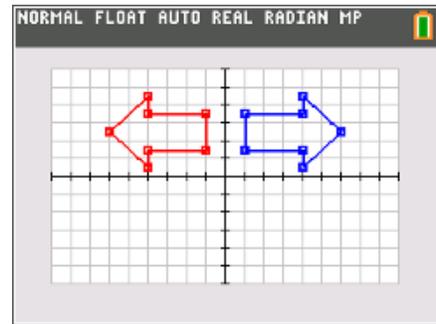
- This activity is designed to be used in a high school geometry or algebra classroom.
- If an original point on the coordinate plane is denoted by  $(x, y)$ , then each of the following ordered pairs denotes a transformation:
 

$(x, -y)$ reflect over $x$ -axis	$(-y, x)$ rotate $90^\circ$ around origin
$(-x, y)$ reflect over $y$ -axis	$(-x, -y)$ rotate $180^\circ$ around origin
$(y, x)$ reflect over $y = x$	$(y, -x)$ rotate $90^\circ$ around origin
- To perform a translation, add or subtract a constant from the list with the  $x$ -values or the  $y$ -values of the figure.
- This activity is designed to be student-centered with the teacher acting as a facilitator while students work cooperatively. If desired, have students work in groups of 3. Each person in the group should enter a different combination of lists for Problem 2 and the group should discuss the results.

### Activity Materials

- Compatible TI Technologies:
  - TI-84 Plus\*
  - TI-84 Plus Silver Edition\*
  -  TI-84 Plus C Silver Edition
  -  TI-84 Plus CE

\* with the latest operating system (2.55MP) featuring MathPrint™ functionality.



### Tech Tips:

- This activity includes screen captures taken from the TI-84 Plus CE. It is also appropriate for use with the rest of the TI-84 Plus family. Slight variations to these directions may be required if using other calculator models.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at <http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials>
- Any required calculator files can be distributed to students via handheld-to-handheld transfer.

### Lesson Files:

- Transformations\_with\_Lists\_Student.pdf
- Transformations\_with\_Lists\_Student.doc

**Problem 1 – Creating a Scatter Plot**

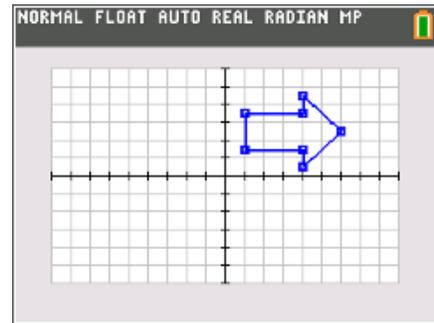
Before beginning the activity, students need to clear all entries from the  $\square$  screen and all lists.

First, students will enter the data on the worksheet into lists **L1** and **L2**.

L1	L2	L3	L4	L5	1
2	3	-----	-----	-----	
8	3				
8	1				
12	5				
8	9				
8	7				
2	7				
2	3				
-----	-----				

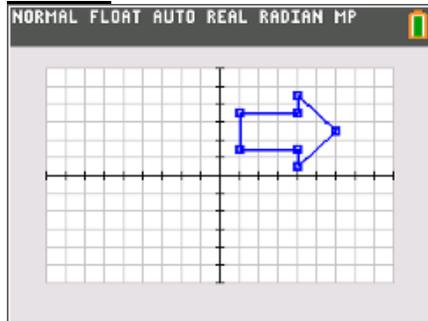
L1(9)=

After setting up **Plot1** for a scatter plot of **L1** vs. **L2** and changing the window settings, students will view the graph and sketch the figure on the worksheet.



1. Sketch the scatter plot.

**Answer:**



**Problem 2 – Reflections and Rotations**

In the list editor, students are to enter the formulas  $-L1$  and  $-L2$  for **L3** and **L4** respectively. This will allow them to create several different reflections and rotations of the original figure.

To type **L1**, students need to press  $\square$   $\square$ .

To type **L2**, students need to press  $\square$   $\square$ .

L1	L2	L3	L4	L5	4
2	3	-2	-3	-----	
8	3	-8	-3		
8	1	-8	-1		
12	5	-12	-5		
8	9	-8	-9		
8	7	-8	-7		
2	7	-2	-7		
2	3	-2	-3		
-----	-----	-----	-----		

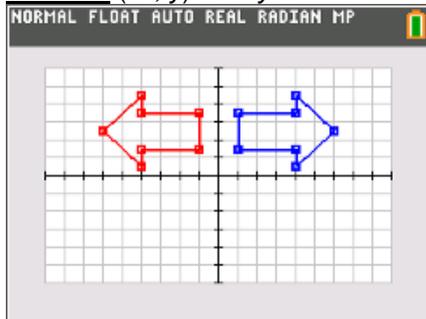
L4(1)= -3



For each combination of lists, students are to determine what type of reflection occurred.

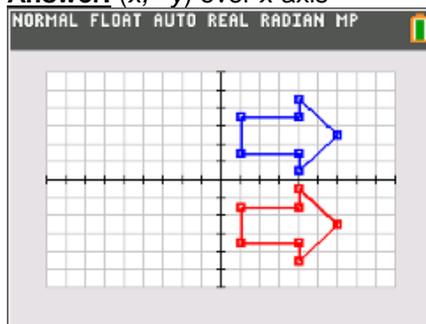
2.  $x \leftarrow L3$  and  $y \leftarrow L2$

**Answer:**  $(-x, y)$  over  $y$ -axis



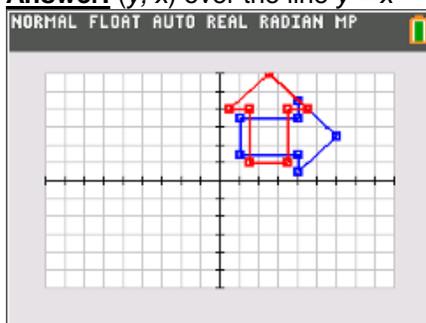
3.  $x \leftarrow L1$  and  $y \leftarrow L4$

**Answer:**  $(x, -y)$  over  $x$ -axis



4.  $x \leftarrow L2$  and  $y \leftarrow L1$

**Answer:**  $(y, x)$  over the line  $y = x$

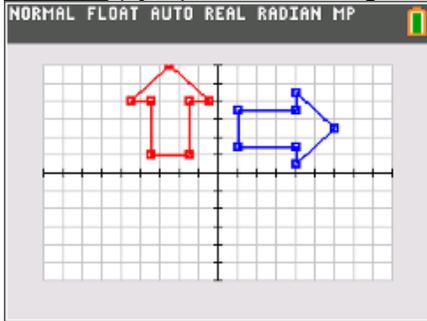




Use **Plot2** to create the following scatter plots. For each combination, determine what type of rotation occurred.

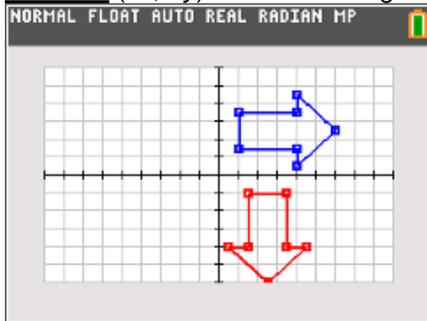
5.  $x \leftarrow L4$  and  $y \leftarrow L1$

**Answer:**  $(-y, x)$   $90^\circ$  around origin



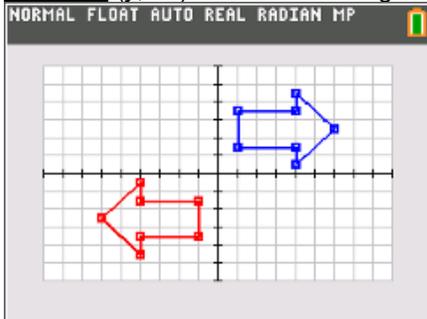
6.  $x \leftarrow L2$  and  $y \leftarrow L3$

**Answer:**  $(-x, -y)$   $90^\circ$  around origin



7.  $x \leftarrow L3$  and  $y \leftarrow L4$

**Answer:**  $(y, -x)$   $180^\circ$  around origin

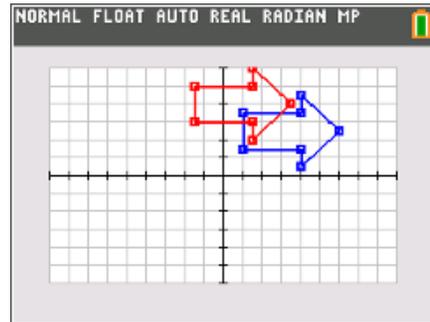




### Problem 3 – Translations

In the list editor, students are to enter the formulas  $=L1-5$  and  $=L2+3$  for **L3** and **L4** respectively. This will allow them to translate the original figure.

Students should see that the image shifted to the left 5 units and up 3 units. Remind students that the tick marks on the graph are every 2 units.



8. Where did the image shift? How many units left/right and how many units up/down?

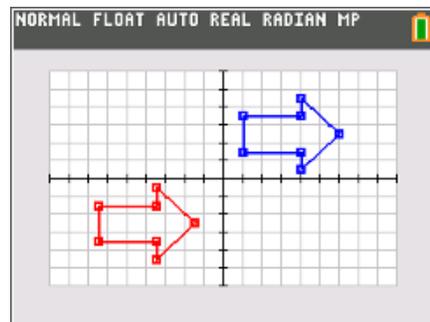
**Answer:** The image shifted to the left 5 units and up 3 units.

Now students are to translate the scatter plot into Quadrant 3 by editing the formula bars for **L3** and **L4**. Possible formulas are below.

**L3** formula:  $=L1-15$

**L4** formula:  $=L2-10$

The image shifted 15 units to the left and 10 units down.



9. Translate the scatter plot into Quadrant 3 by editing the formula bars for **L3** and **L4**.

**L3** formula: \_\_\_\_\_

**L4** formula: \_\_\_\_\_

Explain how the image shifted.

**Sample Answer:** **L3** formula:  $=L1-15$ ; **L4** formula:  $=L2-10$ ; The image shifted 15 units to the left and 10 units down.

### Problem 4 – Dilations

In the list editor, students are to enter the formulas  $=0.5*L1$  and  $=0.5*L2$  for **L3** and **L4** respectively. This will allow them to dilate the original figure.

Students should see that the image decreased in size. If they have trouble seeing the image, they can the mark of the plot to the small dot.

L1	L2	L3	L4	L5	4
2	3	1	-----	-----	
8	3	4			
8	1	4			
12	5	6			
8	9	4			
8	7	4			
2	7	1			
2	3	1			
-----	-----	-----			

$L4=0.5*L2$

10. Explain what happened to the image.

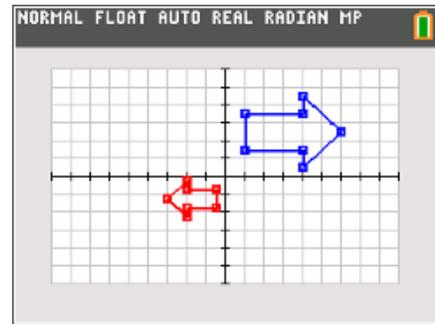
**Sample Answer:** The image decreased in size.



Then students are to dilate the scatter plot into Quadrant 3 by editing the formula bars for **L3** and **L4**. Remind students that the scale factor needs to be the same for both lists. Possible formulas are below.

**L3** formula: =  $-0.5*L1$

**L4** formula: =  $-0.5*L2$



11. Dilate the scatter plot into Quadrant 3 by editing the formula bars for **L3** and **L4**.

**L3** formula: \_\_\_\_\_

**L4** formula: \_\_\_\_\_

Explain what happened to the image.

**Sample Answer:** **L3** formula: =  $-0.5*L1$ ; **L4** formula: =  $-0.5*L2$ ; The image decreased in size and is a reflection across the  $y$ -axis.