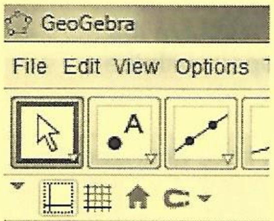
Transformations and Coordinates
(With Geogebra)

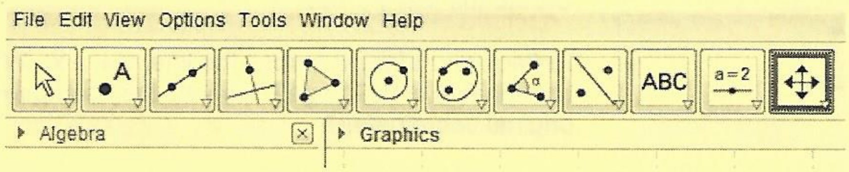
Open Geogebra. Once the program is opened, make sure of the following:

- The coordinate axes are shown
- The grid is on
- The algebra window shows on the left



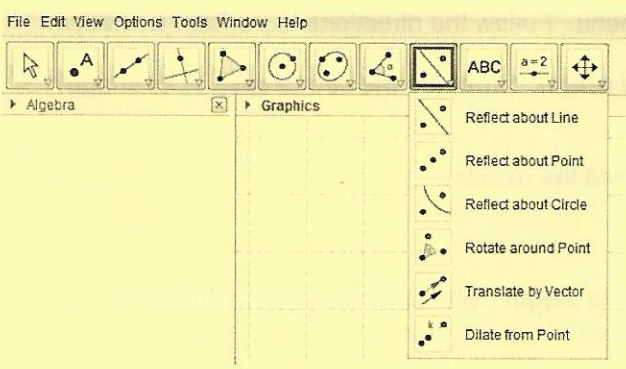
You can turn the axes and grid on by clicking on the icons below the pull down icon bar. The algebra window can be shown by selecting "view" and selecting "algebra". Your grid should be 1 by 1, but your axes will not be centered. You can center them by selecting the last tool "move graphics view" (see below). The pointer will look like a hand and you can grab the screen and move the axes. You may need to use this tool later in your work if some images you make fall "off the screen"

During your work, if you need to "escape" what you are doing, click on the arrow icon (first one).



Create a triangle
Choose the polygon icon (fifth one in picture above). If you hover over the icon, the program will direct you how to do the construction. Draw a triangle whose vertices have integer coordinates. Don't use the origin for a vertex. You will see the vertices' coordinates in the "algebra" window. Write the results on your recording sheet in the first column. You will use this triangle for all your explorations.

Transformations Menu:



You will use this menu for all your different transformations explorations.

Reflections about a line:

Select "reflect about line" and then hover above the icon to get instructions on what to do.

Reflect your triangle across the **y-axis** by selecting the triangle and then selecting the y-axis. Record the coordinates of your image triangle (A´, B´, and C´) that are listed in the algebra window.

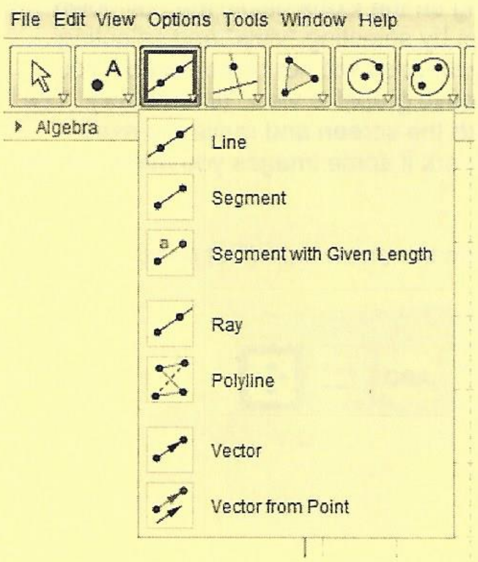
Discuss with your partner how the image vertices compare with the original vertices. Record your analysis.

Use the back arrow in the upper right to delete the transformation after you have analyzed the results. Do not delete the original triangle that you created. You will use this with each of the following constructions.

Reflect your triangle across the **x-axis**. What are the coordinates of its image? How do they compare with the original coordinates?

Delete the transformation after you have analyzed the results.

Create the line y = x. As before, hover above the icon to get instructions.



Reflect your triangle across the line, **y = x**. What are the coordinates of its image? How do they compare with the original coordinates?

Delete back to the original triangle after you have analyzed the results.

Create the line y = - x.

Reflect your triangle across the line, **y = - x.** What are the coordinates of its image? How do they compare with the original coordinates?

Delete back to the original triangle after you have analyzed the results.

Rotations around a point:

The rotations you do will have the center of rotation as the origin. You will have to place a point there by using the second icon.

Select "rotate around a point" from the transformation menu. Follow the directions to perform a rotation.

Rotate your triangle **90 degrees CW with center at the origin**. What are the coordinates of its image? How do they compare with the original coordinates?

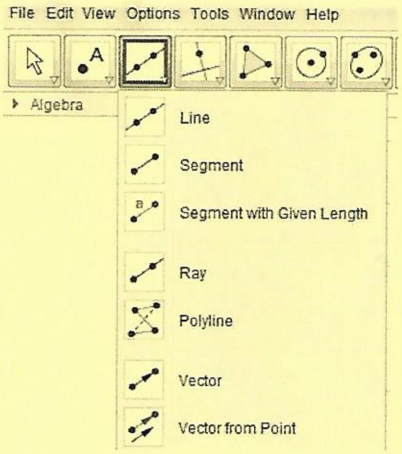
Delete back to the original triangle after you have analyzed the results.

Rotate your triangle 180 degrees CW with center at the origin. What are the coordinates of its image? How do they compare with the original coordinates?

Delete back to the original triangle after you have analyzed the results.

Optional: Rotate your triangle 270 degrees CW with center at the origin.

Translations



To perform a translation, the program needs to know the direction of your "slide". To do so, you will create a vector. After you select "vector", select a starting point and an ending point. Use points that are not near your triangle. The vector will appear as an arrow which shows the direction and the distance you will translate your triangle. Describe how you get from the first point you chose to the final point. What horizontal and vertical movements are you making?

Translate your triangle using the vector you made. Select "translate by vector" from the transformation menu. Follow the directions. What are the coordinates of its image? How do they compare with the original coordinates?

Move your vector by pulling on the final point. How has your vector's direction and distance changed. How did the triangle images' coordinates change in relationship to the vector?

Delete back to the original triangle after you have analyzed the results.

Dilation from a point:

The dilations you do will have the center of dilation as the origin. You will have to place a point there by as you did doing rotations. The point at the origin may still be there from your previous work.

Select "dilate from point" from the transformation menu. Follow the directions. Using the origin as the center of your dilation, use a **scale factor of 2** to dilate your triangle. What are the coordinates of its image? How do they compare with the original coordinates?

Delete back to the original triangle after you have analyzed the results.

Using the origin as the center of your dilation, **use a scale factor of** $\frac{1}{2}$ to dilate your triangle. What are the coordinates of its image? How do they compare with the original coordinates?

Delete back to the original triangle after you have analyzed the results.

Extensions

What will occur if the triangle is **reflected in the y-axis** and then that result is **reflected in the x-axis?** Record your results. Delete back to the original triangle after you have analyzed the results.

Using the origin as the center of your dilation, **use a scale factor of -1** to dilate your triangle. What are the results?

What can you conclude about these 2 transformations and any of the others that you did?

Δ8. G.A.3

Transformations and Coordinates Recording Sheet (geogebra)

Record your findings below as directed in the exploration materials.

Δ vertices (pre-image)	Transformation (image)	Analysis
A (,) B (,) C (,)	**Reflection** over y-axis: A′ (,) B′ (,) C′ (,)	
	Reflection over x-axis: A′ (,) B′ (,) C′ (,)	
	Reflection over y = x: A′ (,) B′ (,) C′ (,)	
	Reflection over y = - x: A′ (,) B′ (,) C′ (,)	
	Rotation of 90°: A′ (,) B′ (,) C′ (,)	
	Rotation of 180°: A′ (,) B′ (,) C′ (,)	
	Rotation of 270°: A′ (,) B′ (,) C′ (,)	
	Translation of ____ horizontal ____ vertical: A′ (,) B′ (,) C′ (,)	
	Translation of ____ horizontal ____ vertical: A′ (,) B′ (,) C′ (,)	

<table>
<tr><th>Δ vertices
(pre-image)</th><th>Transformation</th><th>Analysis</th></tr>
<tr><td rowspan="6">A
(,)

B
(,)

C
(,)</td><td>Dilation, scale factor 2 A´ (,)
B´ (,)
C´ (,)</td><td></td></tr>
<tr><td>Dilation, scale factor $\frac{1}{2}$ A´ (,)
B´ (,)
C´ (,)</td><td></td></tr>
<tr><td colspan="2">Extensions</td></tr>
<tr><td>Reflection over y-axis: A´ (,)
B´ (,)
C´ (,)
Followed by
Reflection over x-axis: A" (,)
B" (,)
C" (,)</td><td></td></tr>
<tr><td>Dilation, scale factor -1 A‴(,)
B‴(,)
C‴(,)</td><td></td></tr>
<tr><td></td><td></td></tr>
</table>

Geometry Standards

Understand congruence and similarity using physical models, transparencies, or geometry software.

Δ8.G.A.1. Verify experimentally the properties of rotations, reflections, and translations:
- a. Lines are taken to lines, and line segments to line segments of the same length.
- b. Angles are taken to angles of the same measure.
- **c.** Parallel lines are taken to parallel lines.

Δ8.G.A.2. Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them.

Δ8.G.A.3. Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.

Δ8.G.A.4. Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them.

Δ8.G.A.5. Use informal arguments to establish facts about the angle sum and exterior angle of triangles, about the angles created when parallel lines are cut by a transversal, and the angle-angle criterion for similarity of triangles. *For example, arrange three copies of the same triangle so that the sum of the three angles appears to form a line, and give an argument in terms of transversals why this is so.*

Understand and apply the Pythagorean Theorem.

8.G.B.6. Explain a proof of the Pythagorean Theorem and its converse.

8.G.B.7 Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.

8.G.B.8. Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.

Solve real-world and mathematical problems involving volume of cylinders, cones, and spheres.

Δ8.G.C.9 Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.

Δ **These standards are in a seventh grade accelerated course.**