

Matrix Reflections

Lesson Plan Level: Geometry; Algebra II

Graphing Calculate: FX-9860G Plus; FX-9860 G Slim

Objective: The student will be able to:

1. Use the RUN-MAT Menu of a graphing calculator to find the new coordinates of a polygon that is reflected the x-axis, y-axis, and the line $y = x$ and
2. Verify the results algebraically.

Engage

Review the terminology related to coordinate axes. Discuss the graph of the line $y = x$. Discuss with students the meaning of a translation and demonstrate a simple reflection without coordinates. Discuss how reflections are used in graphic arts and design.

Explore

Using the calculator, model using the RUN-MAT Menu of the graphing calculator and matrix operations.

Explain:

Students will be able to explain the changes in the coordinates of a polygon for each of the given reflections.

Evaluate:

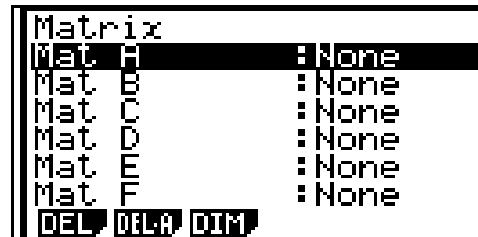
The student will be able to demonstrate their results using the calculator and an over head or LCD projector.

Extensions:

The students will be able to create a simple graphic design using reflections of lines and polygons using a geometry program.

Calculator Notes: Operations with Matrices

To set up the calculator and access the matrix editor in the RUN-MAT Menu using the linear mode, press **SHIFT** **MENU** **F2** **EXE** **F1**. The screen will look like the one at the right. Notice the soft key menus at the bottom of the screen.



These are the uses for the soft keys.

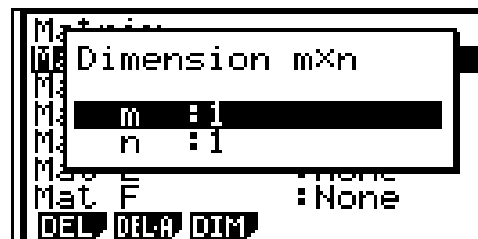
DEL - This is used to delete the contents of the highlighted matrix.

DEL-A - This is used to delete the contents of all the matrices.

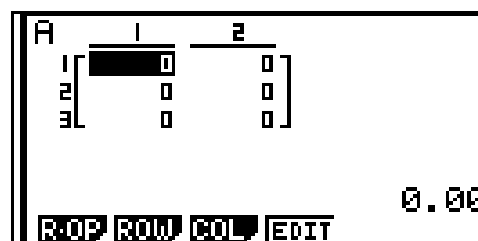
DIM - This is one way to set up the dimensions of the matrix.

Press the **▶** key and the screen will change as shown at the right. In this screen, m represents the number of rows and n represents the number of columns. For this activity, you will want to enter

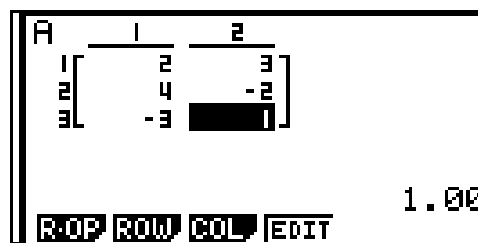
3 **EXE** **2** **EXE** **EXE**.



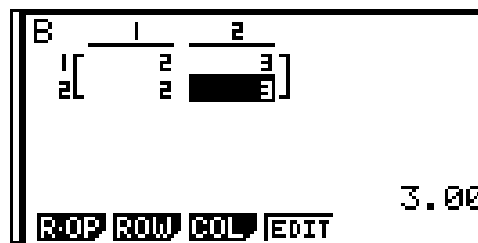
The screen will appear as shown at the right. To enter the values into the matrix, input the value that corresponds to the highlighted cell and press **EXE**.



Inputting the vertices of (2, 3), (4, -2), and (-3, 1) will result in the screen at the right. Press **EXIT**.



Press **▼** **▶** **2** **EXE** **2** **EXE** **EXE** and enter the values of **2** **EXE** **3** **EXE** **2** **EXE** **3** **EXE**.



Student Activity Sheet - Matrix Reflections

Name: _____

Date: _____

Objective: Given the coordinates of a polygon, the student will:

1. Use a graphing calculator to create a matrix for the coordinates of the polygon,
2. Use a graphing calculator to create matrices to reflect the polygon across the x-axis, y-axis, and the line $y = x$,
3. Find the new coordinates of the vertices for the polygon for each reflection, and
4. Verify the results algebraically.

Introduction:

One of the many uses of reflecting points is in the use of graphic design and building construction. These uses can be seen in fabric patterns, architecture, and animation. There are also uses for translating radio waves for cell phones and satellites.

Materials:

- a. Casio FX-9860G+ Graphing Calculator
- b. Student Answer Sheet

Formulas:

$$a. \begin{bmatrix} x_1' & y_1' \\ x_2' & y_2' \\ x_3' & y_3' \end{bmatrix} = \begin{bmatrix} x_1 & y_1 \\ x_2 & y_2 \\ x_3 & y_3 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} \quad \text{- reflection across the x-axis}$$

$$b. \begin{bmatrix} x_1' & y_1' \\ x_2' & y_2' \\ x_3' & y_3' \end{bmatrix} = \begin{bmatrix} x_1 & y_1 \\ x_2 & y_2 \\ x_3 & y_3 \end{bmatrix} \cdot \begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix} \quad \text{- reflection across the y-axis}$$

$$c. \begin{bmatrix} x_1' & y_1' \\ x_2' & y_2' \\ x_3' & y_3' \end{bmatrix} = \begin{bmatrix} x_1 & y_1 \\ x_2 & y_2 \\ x_3 & y_3 \end{bmatrix} \cdot \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \quad \text{- reflection across the line } y = x$$

Procedure:

1. Use the calculator to find the new coordinates for Triangle ABC and fill in the table.
2. Use the calculator to find the new coordinates for Parallelogram ABCD and fill in the table.
3. Verify your answers algebraically on a separate sheet of paper.
4. Answer the questions concerning your findings.

Table 1:

Triangle ABC		Triangle A'B'C'			
			x-axis	y-axis	y = x
Point A	(3, 2)	Point A'			
Point B	(-2, -2)	Point B'			
Point C	(-4, 3)	Point C'			

Table 2:

Parallelogram ABCD		Parallelogram A'B'C'D'			
			x-axis	y-axis	y = x
Point A	(4, 2)	Point A'			
Point B	(2, -2)	Point B'			
Point C	(-5, -2)	Point C'			
Point D	(-3, 2)	Point D'			

Questions:

1. What change takes place when a figure is reflected across the x-axis? _____

2. What change takes place when a figure is reflected across the y-axis? _____

3. What change takes place when a figure is reflected across the line $y = x$? _____

4. Did you get the same results using algebra? _____
5. If a triangle whose vertices are (-12, 10), (6, -8) and (-3, 4) is reflected across the x-axis, what would be the coordinates of the new triangle? _____
6. If a rectangle whose vertices are (-5, 4), (-5, -2), (3, -2) and (3, 4) is reflected across the y-axis, what would be the coordinates of the new rectangle? _____
7. In your own words, describe how to find the new coordinates for a reflection across the line $y = x$. _____

Solutions:

Table 1:

Triangle ABC		Triangle A'B'C'			
			x-axis	y-axis	y = x
Point A	(3, 2)	Point A'	(3, -2)	(-3, 2)	(2, 3)
Point B	(-2, -2)	Point B'	(-2, 2)	(2, -2)	(-2, -2)
Point C	(-4, 3)	Point C'	(-4, -3)	(4, -3)	(3, -4)

Table 2:

Parallelogram ABCD		Parallelogram A'B'C'D'			
			x-axis	y-axis	y = x
Point A	(4, 2)	Point A'	(4, -2)	(-4, 2)	(2, 4)
Point B	(2, -2)	Point B'	(2, 2)	(-2, -2)	(-2, 2)
Point C	(-5, -2)	Point C'	(-5, 2)	(5, -2)	(-2, -5)
Point D	(-3, 2)	Point D'	(-3, -2)	(3, 2)	(2, -3)

1. The sign of the y-coordinate changes to the opposite.
2. The sign of the x-coordinate changes to the opposite.
3. The coordinates are reversed.
4. Yes
5. (-12, -10) (6, 8) (-3, -4)
6. (5, 4) (5, -2) (-3, -2) (-3, 4)
7. Answers will vary.