LESSON **4-3**

Success for English Language Learners

Using Matrices to Transform Geometric Figures

Steps for Success

Step I Initiate the lesson by following these strategies.

- Discuss the meanings of the words *translation, reflection,* and *rotation.* Have students compare the English words and definitions to those of their native languages. Connect the meanings of these words with the vocabulary words *translation matrix, reflection matrix,* and *rotation matrix.*
- Point out that the *y*-coordinate is vertical and the *x*-coordinate is horizontal. Explain that the value to the left of 0 on the *x*-coordinate and the value below 0 on the *y*-coordinate are negative. Also explain that the values of the units in a coordinate plane are equal. Point out that in the examples in the text, each line, or unit, has a value of 1.

Step II Follow these steps to help students better understand how to use matrices to transform geometric figures on a coordinate plane.

- Have students use graph paper as they work through each example. Less proficient students can get help from those with a strong grasp of the concept.
- Have students color-coordinate their work. In the examples in the text, the original shapes are blue and the transformed images are red. Students can follow the same color-coordination.

Step III Ask English Language Learners to complete the worksheet for this lesson.

- Example 3 in the student textbook is supported by Problem 1. Discuss the fact that a reflection matrix is a mirror image. It is symmetric, but it is on the opposite side of a plane or point. Point out that the image will be on the opposite side of the *y*-axis.

Making Connections

- Use a mirror to demonstrate a reflection. Explain that a reflection is a symmetric image on the opposite side of a point or plane. Ask students to share experiences of when they viewed reflections. Then have students share their knowledge of the words *rotate* and *translate* (transfer). Ask students to share their experiences of when items were rotated or translated. Make connections to the mathematical concepts in this lesson.

Name ________________________________ Date ___________ Class ____________

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Problem 1

Reflect $\triangle JKL$ with coordinates $J(3, 4)$, $K(4, 2)$, and $L(1, -2)$ across the y-axis. Find the coordinates of the vertices of the image and graph.

Three points form a triangle.

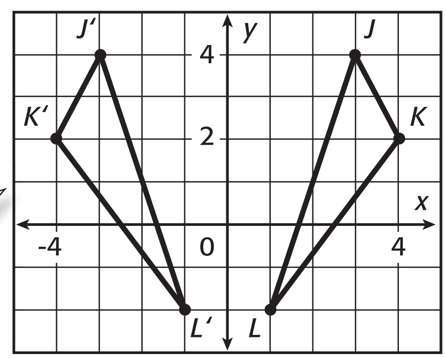
x-coordinate

$$\begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 3 & 4 & 1 \\ 4 & 2 & -2 \end{bmatrix} = \begin{bmatrix} -3 & -4 & -1 \\ 4 & 2 & -2 \end{bmatrix}$$

y-coordinate

Each *x*-coordinate is multipled by -1.
Each *y*-coordinate is multiplied by 1.

A reflection matrix is a matrix that creates a mirror image by reflecting each vertex.



Multiplying the matrix of this figure by $\begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}$ results in a mirror image across the *y*-axis.

Think and Discuss

1. How do you know that this example demonstrates a reflection matrix of $\triangle JKL$?

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2. What is the line of symmetry the image is reflected over?

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Lesson 2-5

1. If the sign is "or equal to," the boundary line is included.
2. The boundary would be vertical.

Lesson 2-6

1. $1f(x) = 2x - 1$
2. It would be a compression.

Lesson 2-7

1. It would have a greater negative slope.
2. Closer to -1.

Lesson 2-8

1. There would be no solution.
2. $2x + 1 > 5$ OR $2x + 1 < -5$

Lesson 2-9

1. The vertex should be 2 units up.
2. The slope would increase times 30 and the vertex would be $(0, -60)$.

CHAPTER 3

Lesson 3-1

1. The lines will intersect at $(2, 4)$.
2. One solution, $(2, 4)$.
3. The slopes are equal.

Lesson 3-2

1. I should get the same answer.
2. Because only one point solves both equations simultaneously.
3. Because equations are added together to eliminate a variable.

Lesson 3-3

1. Quadrants II, III, and IV
2. No, because one of the boundary lines is not included in the region.
3. an obtuse angle

Lesson 3-4

1. It does not maximize the objective function.
2. If the last constraint is removed, the feasible region has vertices at $(0, 0)$, $(0, 300)$, and $(500, 0)$. C is maximized at $(500, 0)$.

Lesson 3-5

1. $(4, 0, 0)$, $(0, 3, 0)$, and $(0, 0, 6)$
2. The equation says that 3 times the x-coordinate plus 4 times the y-coordinate plus 2 times the z-coordinate equals 12 for any point on the plane.

Lesson 3-6

1. That is (z, x, y), which is different from (x, y, z) because the coordinates are ordered.
2. It is independent because the system has one solution only.

CHAPTER 4

Lesson 4-1

1. The entry at c_{22} is 0.0075 and it is the cost per square inch of a 4-inch paper box.
2. c_{32}
3. 4×2

Lesson 4-2

1. Because the number of columns in the first matrix is the same as the number of rows in the second matrix.
2. The matrices of the products have different dimensions.

Lesson 4-3

1. The coordinates in the product matrix are those of the reflected image of *JKL.*
2. It is reflected across the y-axis.