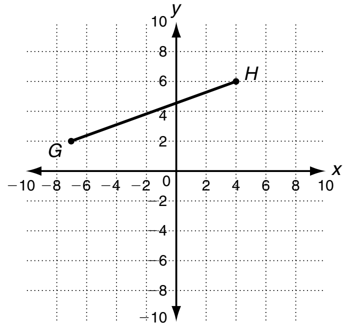
Name ________________________ Date ____________ Class ____________

LESSON 4-3

Practice A

Using Matrices to Transform Geometric Figures

Line segment *GH* has endpoints *G*(−7, 2) and *H*(4, 6). Use line segment *GH* for Exercises 1–6.



Use a matrix to transform line segment *GH*. Find the coordinates of the image endpoints *G*'*H*'.

1. Translate 2 units right and 8 units down.

$$\begin{bmatrix} -7 & 4 \\ 2 & 6 \end{bmatrix} + \begin{bmatrix} 2 & 2 \\ -8 & -8 \end{bmatrix}$$

$$= \begin{bmatrix} -7 + 2 & 4 + (\_\_\_\_) \\ (\_\_\_\_) + (\_\_\_\_) & (\_\_\_\_) + (\_\_\_\_) \end{bmatrix}$$

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2. Translate 5 units right and 1 unit up.

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3. Translate 6 units left and 3 units down.

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4. Enlarge by a factor of 8.

$$8\begin{bmatrix} -7 & 4 \\ 2 & 6 \end{bmatrix}$$

$$= \begin{bmatrix} 8(\_\_\_\_) & 8(\_\_\_\_) \\ \_\_\_\_\ (\_\_\_\_) & \_\_\_\_\ (\_\_\_\_) \end{bmatrix}$$

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5. Enlarge by a factor of 5.

____

6. Reduce by a factor of 0.5.

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Use each matrix to reflect the given point. Write the coordinates of the image. Tell which axis the point is reflected across.

7. $\begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}$; (2, −3)

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

$$= \begin{bmatrix} -1(\_\_\_\_) + 0(\_\_\_\_) \\ \_\_\_\_(\_\_\_\_) + \_\_\_\_(\_\_\_\_) \end{bmatrix}$$

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8. $\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$; (−10, 1)

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9. $\begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}$; (5, 4)

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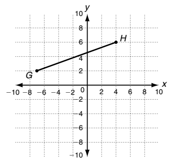
LESSON 4-3

Practice A

Using Matrices to Transform Geometric Figures

Line segment *GH* has endpoints *G*(−7, 2) and *H*(4, 6). Use line segment *GH* for Exercises 1–6.



Use a matrix to transform line segment *GH*. Find the coordinates of the image endpoints *G′H′*.

1. Translate 2 units right and 8 units down.

$$\begin{bmatrix} -7 & 4 \\ 2 & 6 \end{bmatrix} + \begin{bmatrix} 2 & 2 \\ -8 & -8 \end{bmatrix}$$

$$= \begin{bmatrix} -7+2 & 4+(\underline{2}) \\ (\underline{2})+(\underline{-8}) & (\underline{6})+(\underline{-8}) \end{bmatrix}$$

G′(−5, −6), *H′*(6, −2)

2. Translate 5 units right and 1 unit up.

G′(−2, 3), *H′*(9, 7)

3. Translate 6 units left and 3 units down.

G′(−13, −1), *H′*(−2, 3)

4. Enlarge by a factor of 8.

$$8\begin{bmatrix} -7 & 4 \\ 2 & 6 \end{bmatrix}$$

$$= \begin{bmatrix} 8(\underline{-7}) & 8(\underline{4}) \\ \underline{8}(\underline{2}) & \underline{8}(\underline{6}) \end{bmatrix}$$

G′(−56, 16), *H′*(32, 48)

5. Enlarge by a factor of 5.

G′(−35, 10), *H′*(20, 30)

6. Reduce by a factor of 0.5.

G′(−3.5, 1), *H′*(2, 3)

Use each matrix to reflect the given point. Write the coordinates of the image. Tell which axis the point is reflected across.

7. $\begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}$; (2, −3)

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

$$= \begin{bmatrix} -1(\underline{2}) + 0(\underline{-3}) \\ \underline{0}(\underline{2}) + \underline{1}(\underline{-3}) \end{bmatrix}$$

(−2, −3); *y*-axis

8. $\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$; (−10, 1)

(−10, −1); *x*-axis

9. $\begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}$; (5, 4)

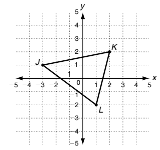
(−5, 4); *y*-axis

LESSON 4-3

Practice B

Using Matrices to Transform Geometric Figures

Triangle *JKL* has vertices *J*(−3, 1), *K*(2, 2), and *L*(1, −2).



Use a matrix to transform triangle *JKL*. Find the coordinates of the vertices of the image.

1. Translate 5 units right, 6 units down.

J′(2, −5), *K′*(7, −4), *L′*(6, −8)

2. Translate 2 units left, 4 units up.

J′(−5, 5), *K′*(0, 6), *L′*(−1, 2)

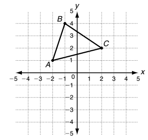
3. Enlarge by a factor of 7.

J′(−21, 7), *K′*(14, 14), *L′*(7, −14)

4. Reduce by a factor of 0.25.

J′(−0.75, 0.25), *K′*(0.5, 0.5), *L′*(0.25, −0.5)

Reflect or rotate triangle *ABC* with vertices *A*(−2, 1), *B*(−1, 4), and *C*(2, 2). Find the coordinates of the vertices of the image. Describe the transformation.



5. $\begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}$

A′(2, 1), *B′*(1, 4), *C′*(−2, 2); reflection across the *y*-axis

6. $\begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$

A′(1, 2), *B′*(4, 1), *C′*(2, −2); 90° clockwise rotation

7. $\begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}$

A′(−1, −2), *B′*(−4, −1), *C′*(−2, 2); 90° counterclockwise rotation

8. $\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$

A′(−2, −1), *B′*(−1, −4), *C′*(2, −2); reflection across the *x*-axis

Solve.

9. a. Natalie drew a figure with vertices *H*(−3, −2), *O*(−3, 3), *U*(0, 5), *S*(3, 3), *E*(3, −2) to use as a pattern on a sweatshirt. Write a matrix that defines the figure.

$$\begin{bmatrix} -3 & -3 & 0 & 3 & 3 \\ -2 & 3 & 5 & 3 & -2 \end{bmatrix}$$

b. Natalie wants to enlarge the figure by a factor of 5. Describe a method she can use.

Multiply each entry in the matrix by 5.

c. What are the coordinates of Natalie's enlarged figure?

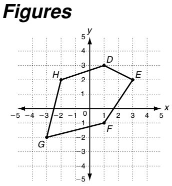
H′ (−15, −10) *O′* (−15, 15) *U′* (0, 25) *S′* (15, 15) *E′* (15, −10)

LESSON 4-3

Practice C

Using Matrices to Transform Geometric Figures

Use a matrix to transform figure *DEFGH* with coordinates *D*(1, 3), *E*(3, 2), *F*(1, −1), *G*(−3, −2), and *H*(−2, 2). Give the transformation matrix or scalar and the coordinates of the image.



1. Translate 9 units left and 4 units up.

$$\begin{bmatrix} -9 & -9 & -9 & -9 & -9 \\ 4 & 4 & 4 & 4 & 4 \end{bmatrix}$$

D′(−8, 7), *E′*(−6, 6), *F′*(−8, 3), *G′*(−12, 2), *H′*(−11, 6)

2. Reduce by a factor of 0.1.

scalar 0.1; *D′*(0.1, 0.3), *E′*(0.3, 0.2), *F′*(0.1, −0.1), *G′*(−0.3, −0.2), *H′*(−0.2, 0.2)

3. Rotation 90° clockwise

$\begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$; *D′*(3, −1), *E′*(2, −3), *F′*(−1, −1), *G′*(−2, 3), *H′*(2, 2)

4. Rotation 90° counterclockwise

$\begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}$; *D′*(−3, 1), *E′*(−2, 3), *F′*(1, 1), *G′*(2, −3), *H′*(−2, −2)

5. Reflection across the *x*-axis

$\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$; *D′*(1, −3), *E′*(3, −2), *F′*(1, 1), *G′*(−3, 2), *H′*(−2, −2)

6. Reflection across the *y*-axis

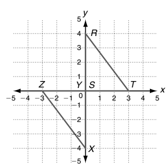
$\begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}$; *D′*(−1, 3), *E′*(−3, 2), *F′*(−1, −1), *G′*(3, −2), *H′*(2, 2)

7. Reflection across $y = x$

$\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$; *D′*(3, 1), *E′*(2, 3), *F′*(−1, 1), *G′*(−2, −3), *H′*(2, −2)

Solve.

8. Yung Li drew triangle *RST* with coordinates *R*(0, 4), *S*(0, 0), and *T*(3, 0). Then she drew triangle *XYZ* with coordinates *X*(0, −4), *Y*(0, 0), and *Z*(−3, 0).



a. Graph triangles *RST* and *XYZ*.

b. Write a coordinate matrix to represent each triangle.

$$\begin{bmatrix} 0 & 0 & 3 \\ 4 & 0 & 0 \end{bmatrix}; \begin{bmatrix} 0 & 0 & -3 \\ -4 & 0 & 0 \end{bmatrix}$$

c. Use the matrices to show the transformation of triangle *RST* into triangle *XYZ*.

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

LESSON 4-3

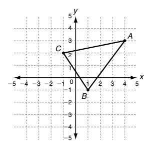
Reteach

Using Matrices to Transform Geometric Figures

A matrix can define a polygon in the coordinate plane.

Vertices of △*ABC*:

A(4, 3), *B*(1, −1), *C*(−1, 2)



Write each pair of coordinates in a column.

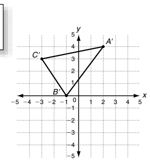
Matrix for △*ABC*: $\begin{bmatrix} 4 & 1 & -1 \\ 3 & -1 & 2 \end{bmatrix}$ ← *x*-coordinates, ← *y*-coordinates

To translate △*ABC* 2 units left and 1 unit up, add a translation matrix to the matrix for △*ABC*.

Translation matrix: $\begin{bmatrix} -2 & -2 & -2 \\ 1 & 1 & 1 \end{bmatrix}$

The *x*-coordinates are translated 2 units left.

The *y*-coordinates are translated 1 unit up.



Add the matrices to find the vertices of the translated image.

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

Translated image, *A′*(2, 4), *B′*(−1, 0), *C′*(−3, 3).

Solve.

1. △*DEF* has vertices *D*(0, 3), *E*(−2, 0), and *F*(1, −2). Write the matrix for △*DEF*.

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

2. Write the translation matrix to translate △*DEF* 3 units right and 2 units down.

$$\begin{bmatrix} 3 & 3 & 3 \\ -2 & -2 & -2 \end{bmatrix}$$

3. Add the matrices to find the coordinates of the vertices of the image △*D′E′F′*. Then graph △*D′E′F′*.

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

D′(3, 1), *E′*(1, −2), *F′*(4, −4);