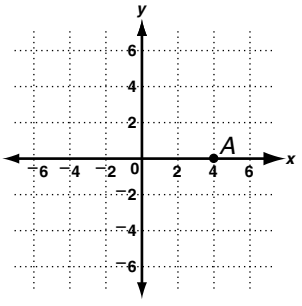
Name _____ Date _____ Class _____

LESSON 1-8

Challenge

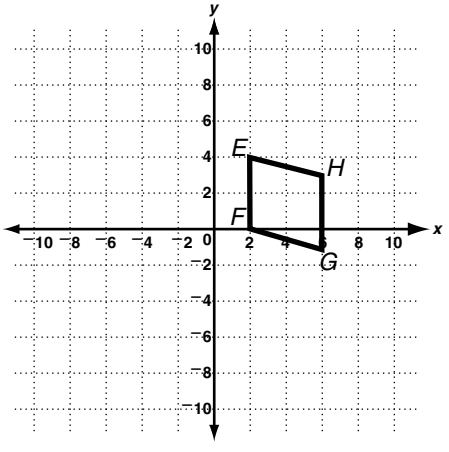
Turn it Around

Translations and reflections are transformations in the position of a figure. A third transformation that preserves congruence is called a **rotation**. Point *A* is at (4, 0). Move point *A* along the semicircle 90° in a counterclockwise direction. The rotated point has coordinates (0, 4). This is called a rotation of 90° counterclockwise centered at the origin.



Use the graph at right for Exercises 1–6.

Rotate figure *EFGH* 90° clockwise through the origin.



1. What are the coordinates of the vertices of the rotated figure?

_____

2. Write a general rule to show the result of rotating a point 90° clockwise through the origin.

_____

3. Write a general rule to show the result of rotating a point 90° counterclockwise through the origin.

_____

To rotate a figure through a point other than the origin, translate the figure so that the point of rotation is at the origin. Then perform the rotation through the origin. Finally, reverse the translation.

Rotate quadrilateral *EFGH* counterclockwise 90° through the point (2, 0). First translate the quadrilateral 2 units left to move the point of rotation, (2, 0), to the origin.

4. What are the coordinates of the vertices of the translated quadrilateral?

_____

Now, rotate the translated quadrilateral 90° counterclockwise through the origin.

5. What are the coordinates of the vertices of the rotated quadrilateral?

_____

Finally, reverse the translation by moving the quadrilateral 2 units right.

6. What are the coordinates of the vertices of the final quadrilateral?

_____

LESSON 1-8

Reteach

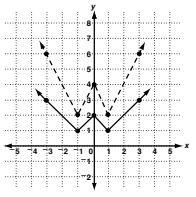
Exploring Transformations (continued)

In a stretch or a compression, the new figure has a different shape than the original.

Horizontal Stretch (away from *y*-axis)	The *x*-coordinate changes. $(x, y) \rightarrow (bx, y)$; $\lvert b \rvert > 1$
Vertical Stretch (away from *x*-axis)	The *y*-coordinate changes. $(x, y) \rightarrow (x, ay)$; $\lvert a \rvert > 1$
Horizontal Compression (toward the *y*-axis)	The *x*-coordinate changes. $(x, y) \rightarrow (bx, y)$; $0 < \lvert b \rvert < 1$
Vertical Compression (toward the *x*-axis)	The *y*-coordinate changes. $(x, y) \rightarrow (x, ay)$; $0 < \lvert a \rvert < 1$

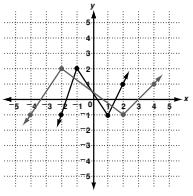
Perform a vertical stretch of the function $y = f(x)$ by a factor of 2.
In a vertical stretch $(x, y) \rightarrow (x, ay)$. In this case, $a = 2$.

Original Figure (solid line)	x	$2y$	**Stretched Figure** (dashed line)
$(-3, 3)$	-3	6	$(-3, 6)$
$(-1, 1)$	-1	2	$(-1, 2)$
$(0, 2)$	0	4	$(0, 4)$
$(1, 1)$	1	2	$(1, 2)$
$(3, 3)$	3	6	$(3, 6)$

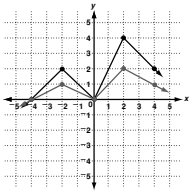


Perform each transformation of $y = f(x)$.

3. horizontal stretch by a factor of 2



4. vertical compression by a factor of $\frac{1}{2}$



LESSON 1-8

Challenge

Turn it Around

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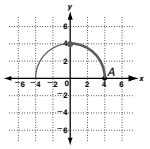
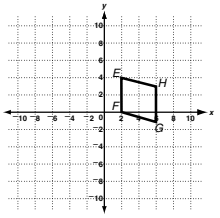


Use the graph at right for Exercises 1–6.

Rotate figure *EFGH* 90° clockwise through the origin.



1. What are the coordinates of the vertices of the rotated figure?

$(4, -2), (0, -2), (-1, -6), (3, -6)$

2. Write a general rule to show the result of rotating a point 90° clockwise through the origin.

$(x, y) \rightarrow (y, -x)$

3. Write a general rule to show the result of rotating a point 90° counterclockwise through the origin.

$(x, y) \rightarrow (-y, x)$

To rotate a figure through a point other than the origin, translate the figure so that the point of rotation is at the origin. Then perform the rotation through the origin. Finally, reverse the translation.

Rotate quadrilateral *EFGH* counterclockwise 90° through the point (2, 0). First translate the quadrilateral 2 units left to move the point of rotation, (2, 0), to the origin.

4. What are the coordinates of the vertices of the translated quadrilateral?

$(0, 4), (0, 0), (4, -1), (4, 3)$

Now, rotate the translated quadrilateral 90° counterclockwise through the origin.

5. What are the coordinates of the vertices of the rotated quadrilateral?

$(-4, 0), (0, 0), (1, 4), (-3, 4)$

Finally, reverse the translation by moving the quadrilateral 2 units right.

6. What are the coordinates of the vertices of the final quadrilateral?

$(-2, 0), (2, 0), (3, 4), (-1, 4)$

LESSON 1-8

Problem Solving

Exploring Transformations

Harry is working on a budget for a concert. The graph shows the total cost of renting the hall. A cleaning fee of $40 for each rental is included in the graph. Use the graph for Exercises 1–6.

1. What is the cost of renting the hall for 2 hours? for 3 hours? for 6 hours? for 7 hours?

$120; $160; $220; $240

2. What is the rate per hour not including the cleaning fee if Harry rents the hall for up to 3 hours?

$40 per hour

3. What is the rate per hour after the first 3 hours?

$20 per hour

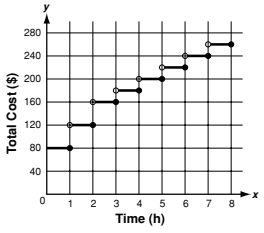
4. Describe the effect on the graph if the cleaning fee were changed to $25.

Translated down 15 units

5. The managers decide that the minimum time for which the hall can be rented is 3 hours. Describe the effect this change would have on the graph above. How would the range change?

Possible answers: A line would go from (0, 160) to (3, 160) with no open circle; the range would not include any numbers less than 160.

Concert Hall Rental



6. The Art Center gives Harry a graph showing its charges. This graph is the same shape as the graph above, but every point has been translated up 10 units. What would be the effect on Harry's budget if he chose to have the concert at the Art Center?

He would have to pay more to rent the Art Center.

Choose the letter for the best answer.

7. Martha's profits from her bagel store last year were $0.35 per dozen bagels sold. This year her profits decreased 10%. What kind of transformation does this represent?

Ⓐ vertical compression
B vertical stretch
C horizontal compression
D horizontal stretch

8. Shana drew the graph for a quadratic function. Then she did a horizontal stretch of the curve. Which transformation did she perform?

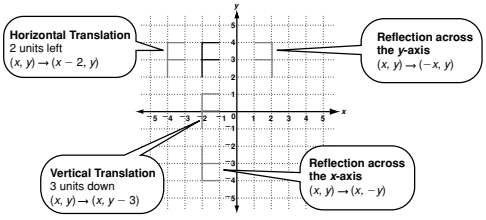
F $(x, y) \rightarrow (x, ay)$; $\lvert a \rvert > 1$
G $(x, y) \rightarrow (bx, y)$; $0 < \lvert b \rvert < 1$
H $(x, y) \rightarrow (x, ay)$; $0 < \lvert a \rvert < 1$
Ⓙ $(x, y) \rightarrow (bx, y)$; $\lvert b \rvert > 1$

LESSON 1-8

Reading Strategies

Understand Vocabulary

A diagram can help you connect transformation vocabulary to corresponding graphs. When you perform a transformation on a graph, the figure is moved according to the type of transformation.



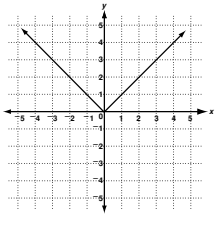
1. What happens to the shape and the position of a figure during a translation or a reflection?

The shape of the figure does not change, only the position changes.

Use the graph for Exercises 2–5.

2. How will the coordinates change if the function is translated 3 units right?

Add 3 to each *x*-coordinate; *y*-coordinates do not change.



3. How will the coordinates change if the function is translated 5 units down?

x-coordinates do not change; subtract 5 from each *y*-coordinate.

4. How will the coordinates change if the function is reflected across the *x*-axis?

x-coordinates do not change; multiply each *y*-coordinate by -1.

5. How will the coordinates change if the function is translated 4 units left and 2 units up?

Subtract 4 from each *x*-coordinate and add 2 to each *y*-coordinate.