Name _____ Date _____

Transformations

Translations and Reflections

A **transformation** changes a figure into another figure. The new figure is called the **image**.

A **translation** is a transformation in which a figure slides but does not turn. Every point of the figure moves the same distance and in the same direction. Translating a figure a units horizontally and b units vertically in a coordinate plane changes the coordinates of the figure as follows.

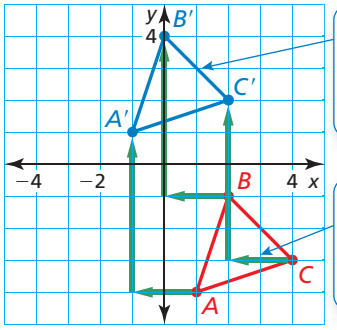
$(x, y) \rightarrow (x + a, y + b)$

A **reflection** is a transformation in which a figure is reflected in a line called the **line of reflection**. A reflection creates a mirror image of the original figure. Reflecting a figure in the x-axis or the y-axis changes the coordinates of the figure as follows.

***x*-axis:** $(x, y) \rightarrow (x, -y)$ ***y*-axis:** $(x, y) \rightarrow (-x, y)$

In a translation or reflection, the original figure and its image are congruent.

Example 1 **Translate the red triangle 2 units left and 5 units up. What are the coordinates of the image?**

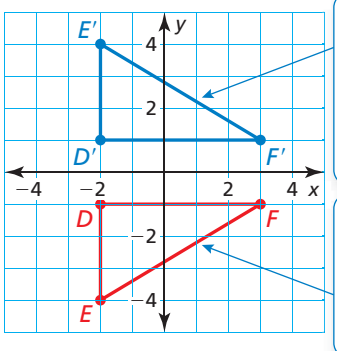


Connect the vertices. Label as A', B', and C'.

Move each vertex 2 units left and 5 units up.

▶ The coordinates of the image are $A'(-1, 1)$, $B'(0, 4)$, and $C'(2, 2)$.

Example 2 **Reflect the red triangle in the *x*-axis. What are the coordinates of the image?**



Plot points D' and F' 1 unit above the x-axis, and plot point E' 4 units above the x-axis. Connect the vertices.

Points D and F are 1 unit below the x-axis, and point E is 4 units below the x-axis.

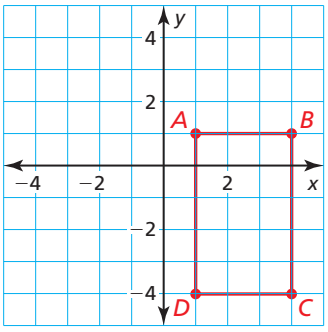
▶ The coordinates of the image are $D'(-2, 1)$, $E'(-2, 4)$, and $F'(3, 1)$.

Practice

Check your answers at BigIdeasMath.com.

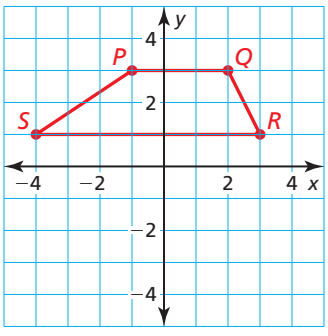
Find the coordinates of the figure after the transformation.

1. Translate the rectangle 2 units left and 3 units up.



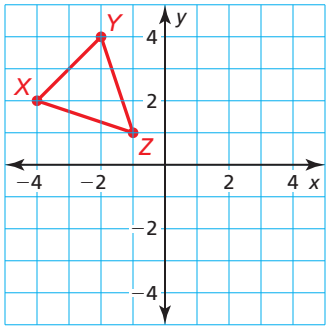
$A'(-1, 4)$, $B'(2, 4)$, $C'(2, -1)$, $D'(-1, -1)$

2. Reflect the trapezoid in the x-axis.



$P'(-1, -3)$, $Q'(2, -3)$, $R'(3, -1)$, $S'(-4, -1)$

3. Reflect the triangle in the y-axis.



$X'(4, 2)$, $Y'(2, 4)$, $Z'(1, 1)$

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Transformations

Rotations and Dilations

A **rotation** is a transformation in which a figure is rotated about a point called the **center of rotation**. The number of degrees a figure rotates is the **angle of rotation**.

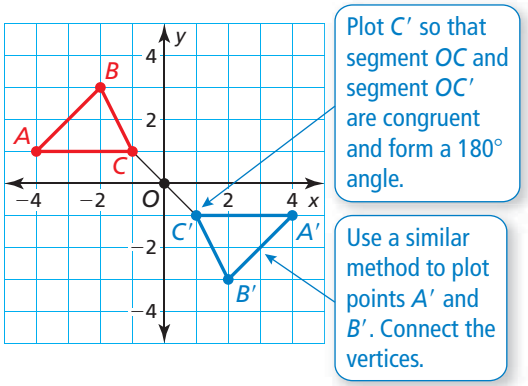
A **dilation** is a transformation in which a figure is made larger or smaller with respect to a point called the **center of dilation**.

In a rotation, the original figure and its image are congruent. In a dilation, the original figure and its image are similar. The ratio of the side lengths of the image to the corresponding side lengths of the original figure is the **scale factor** of the dilation.

Dilating a figure in a coordinate plane with respect to the origin by a scale factor k changes the coordinates of the figure as follows.

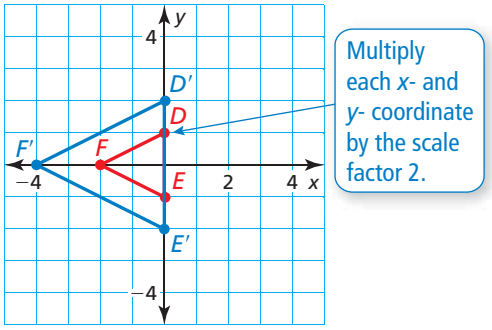
$$(x, y) \rightarrow (kx, ky)$$

Example 1 **Rotate the red triangle 180° about the origin.**



▶ The coordinates of the image are $A'(4, -1)$, $B'(2, -3)$, and $C'(1, -1)$.

Example 2 **Dilate the red triangle with respect respect to the origin using a scale factor of 2.**



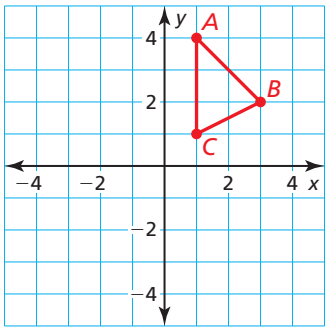
▶ The coordinates of the image are $D'(0, 2)$, $E'(0, -2)$, and $F'(-4, 0)$.

Practice

Check your answers at BigIdeasMath.com.

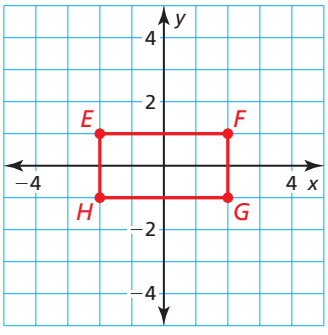
Find the coordinates of the figure after the transformation.

1. Rotate the triangle 90° counterclockwise about the origin.



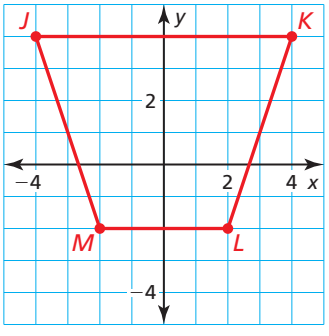
$A'(-4, 1)$, $B'(-2, 3)$, $C'(-1, 1)$

2. Dilate the rectangle with respect to the origin using a scale factor of 3.



$E'(-6, 3)$, $F'(6, 3)$, $G'(6, -3)$, $H'(-6, -3)$

3. Dilate the trapezoid with respect to the origin using a scale factor of $\frac{1}{2}$.



$J'(-2, 2)$, $K'(2, 2)$, $L'(1, -1)$, $M'(-1, -1)$