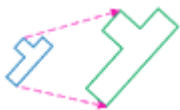


Lesson 4-2

Example 1 Identify Transformations

Identify each transformation as a *reflection*, *translation*, *dilation*, or *rotation*.

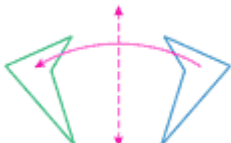
a.



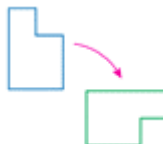
b.



c.



d.



- The figure has been increased in size. This is a dilation.
- The figure has been shifted horizontally to the right. This is a translation.
- The figure has been flipped over a line. This is a reflection.
- The figure has been turned around a point. This is a rotation.

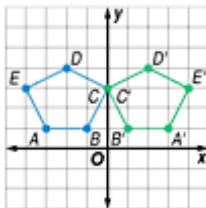
Example 2 Reflection

A pentagon has vertices $A(-3, 1)$, $B(-1, 1)$, $C(0, 3)$, $D(-2, 4)$, and $E(-4, 3)$.

a. **Pentagon $ABCDE$ is reflected over the y -axis. Find the coordinates of the vertices of the image.**

To reflect the figure over the y -axis, multiply each x -coordinate by -1 .

$$\begin{aligned}(x, y) &\rightarrow (-x, y) \\ A(-3, 1) &\rightarrow A'(3, 1) \\ B(-1, 1) &\rightarrow B'(1, 1) \\ C(0, 3) &\rightarrow C'(0, 3) \\ D(-2, 4) &\rightarrow D'(2, 4) \\ E(-4, 3) &\rightarrow E'(4, 3)\end{aligned}$$



The coordinates of the vertices of the image are $A'(3, 1)$, $B'(1, 1)$, $C'(0, 3)$, $D'(2, 4)$, and $E'(4, 3)$.

b. **Graph pentagon $ABCDE$ and its image $A'B'C'D'E'$.**

Graph each vertex of the pentagon $ABCDE$.

Connect the points.

Graph each vertex of the reflected image $A'B'C'D'E'$.

Connect the points.

Example 3 Translation

Parallelogram $QRST$ has vertices $Q(-2, 1)$, $R(1, 1)$, $S(3, 3)$, and $T(0, 3)$.

- a. Find the coordinates translated 1 unit to the right and 3 units up.

To translate the parallelogram 1 unit to the right, add 1 to the x -coordinate of each vertex. To translate the parallelogram 3 units up, add 3 to the y -coordinate of each vertex.

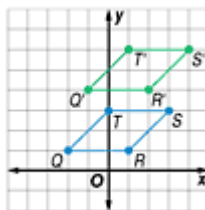
$$\begin{aligned}(x, y) &\rightarrow (x + 1, y + 3) \\ Q(-2, 1) &\rightarrow Q'(-2 + 1, 1 + 3) \rightarrow Q'(-1, 4) \\ R(1, 1) &\rightarrow R'(1 + 1, 1 + 3) \rightarrow R'(2, 4) \\ S(3, 3) &\rightarrow S'(3 + 1, 3 + 3) \rightarrow S'(4, 6) \\ T(0, 3) &\rightarrow T'(0 + 1, 3 + 3) \rightarrow T'(1, 6)\end{aligned}$$

The coordinates of the vertices of the image are $Q'(-1, 4)$, $R'(2, 4)$, $S'(4, 6)$, and $T'(1, 6)$.

- b. Graph parallelogram $QRST$ and its image.

The preimage is parallelogram $QRST$.

The translated image is parallelogram $Q'R'S'T'$.



Example 4 Dilation

A triangle has vertices $X(1, 2)$, $Y(3, 6)$, and $Z(-2, 3)$.

- a. Find the coordinates of the dilated triangle $X'Y'Z'$ if the scale factor is 2.

To dilate the figure multiply the coordinates of each vertex by 2.

$$\begin{aligned}(x, y) &\rightarrow (2x, 2y) \\ X(1, 2) &\rightarrow X'(2 \cdot 1, 2 \cdot 2) \rightarrow X'(2, 4) \\ Y(3, 6) &\rightarrow Y'(2 \cdot 3, 2 \cdot 6) \rightarrow Y'(6, 12) \\ Z(-2, 3) &\rightarrow Z'(2 \cdot (-2), 2 \cdot 3) \rightarrow Z'(-4, 6)\end{aligned}$$

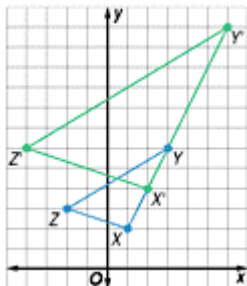
The coordinates of the vertices of the image are $X'(2, 4)$, $Y'(6, 12)$, and $Z'(-4, 6)$.

- b. Graph the preimage and its image.

The preimage is the triangle XYZ .

The image is the triangle $X'Y'Z'$.

Notice that the image has sides that are two times the length of the sides of the original figure.



Example 5 Rotation

Trapezoid $ABCD$ has vertices $A(2, -1)$, $B(-6, -1)$, $C(-4, -5)$, and $D(0, -5)$.

- a. Find the coordinates of the image of trapezoid $ABCD$ after it is rotated 180° about the origin.

To find the coordinates of the vertices after a 180° rotation, multiply both coordinates of each point by -1 .

$$\begin{aligned}(x, y) &\rightarrow (-x, y) \\ A(2, -1) &\rightarrow A'(-2, 1) \\ B(-6, -1) &\rightarrow B'(6, 1) \\ C(-4, -5) &\rightarrow D'(4, 5) \\ D(0, -5) &\rightarrow E'(0, 5)\end{aligned}$$

- b. Graph the preimage and its image.

The image is trapezoid $A'B'C'D'$.

The rotated image is trapezoid $A'B'C'D$.

