4.1 Translations
For use with Exploration 4.1

**Essential Question**  How can you translate a figure in a coordinate plane?

1 **EXPLORATION:** Translating a Triangle in a Coordinate Plane

Go to BigIdeasMath.com for an interactive tool to investigate this exploration.

Work with a partner.

a. Use dynamic geometry software to draw any triangle and label it ΔABC.

b. Copy the triangle and translate (or slide) it to form a new figure, called an image, ΔA′B′C′. (read as “triangle A prime, B prime, C prime”).

c. What is the relationship between the coordinates of the vertices of ΔABC and those of ΔA′B′C′?

d. What do you observe about the side lengths and angle measures of the two triangles?

Sample

2 **EXPLORATION:** Translating a Triangle in a Coordinate Plane

Go to BigIdeasMath.com for an interactive tool to investigate this exploration.

Work with a partner.

a. The point (x, y) is translated a units horizontally and b units vertically. Write a rule to determine the coordinates of the image of (x, y).

   \[(x, y) \rightarrow (____, ____)]
4.1 Translations (continued)

b. Use the rule you wrote in part (a) to translate $\triangle ABC$ 4 units left and 3 units down. What are the coordinates of the vertices of the image, $\triangle A'B'C''$?

c. Draw $\triangle A'B'C'$. Are its side lengths the same as those of $\triangle ABC$? Justify your answer.

EXPLORATION: Comparing Angles of Translations

Work with a partner.

a. In Exploration 2, is $\triangle ABC$ a right triangle? Justify your answer.

b. In Exploration 2, is $\triangle A'B'C'$ a right triangle? Justify your answer.

c. Do you think translations always preserve angle measures? Explain your reasoning.

Communicate Your Answer

4. How can you translate a figure in a coordinate plane?

5. In Exploration 2, translate $\triangle A'B'C'$ 3 units right and 4 units up. What are the coordinates of the vertices of the image, $\triangle A''B''C''$? How are these coordinates related to the coordinates of the vertices of the original triangle, $\triangle ABC$?
In your own words, write the meaning of each vocabulary term.

vector

initial point

terminal point

horizontal component

vertical component

component form

transformation

image

preimage

translation

rigid motion

composition of transformations
Core Concepts

Vectors

The diagram shows a vector. The initial point, or starting point, of the vector is \( P \), and the terminal point, or ending point, is \( Q \). The vector is named \( \overrightarrow{PQ} \), which is read as “vector \( PQ \)” The horizontal component of \( \overrightarrow{PQ} \) is 5, and the vertical component is 3. The component form of a vector combines the horizontal and vertical components. So, the component form of \( \overrightarrow{PQ} \) is \( (5, 3) \).

Notes:

Translations

A translation moves every point of a figure the same distance in the same direction. More specifically, a translation maps, or moves the points \( P \) and \( Q \) of a plane figure along a vector \( \langle a, b \rangle \) to the points \( P' \) and \( Q' \), so that one of the following statements is true.

- \( PP' = QQ' \) and \( PP' \parallel QQ' \), or
- \( PP' = QQ' \) and \( PP' \) and \( QQ' \) are collinear.

Notes:

Extra Practice

In Exercises 1–3, name the vector and write its component form.

1. 

2. 

3. 
4.1 Notetaking with Vocabulary (continued)

In Exercises 4–7, the vertices of \( \triangle ABC \) are \( A(1, 2), B(5, 1), C(5, 4) \).
Translate \( \triangle ABC \) using the given vector. Graph \( \triangle ABC \) and its image.

4. \((-4, 0)\)

5. \((-2, -4)\)

6. \((0, -5)\)

7. \((1, -3)\)

In Exercises 8 and 9, write a rule for the translation of quadrilateral \( PQRS \) to quadrilateral \( P'Q'R'S' \).

8.

9.

In Exercises 10 and 11, use the translation.
\((x, y) \rightarrow (x + 6, y - 3)\)

10. What is the image of \( J(4, 5) \)?

11. What is the image of \( R'(0, -5) \)?

12. In a video game, you move a spaceship 1 unit left and 4 units up. Then, you move the spaceship 2 units left. Rewrite the composition as a single transformation.