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# 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.**

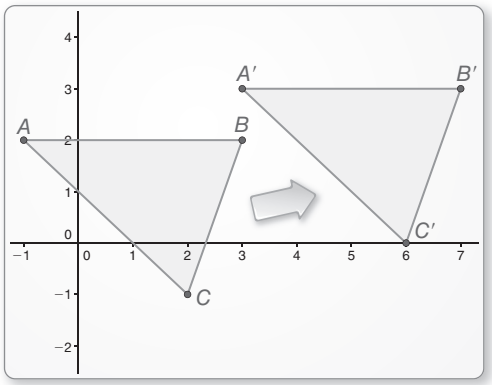
**a.** Use dynamic geometry software to draw any triangle and label it $\triangle ABC$.

**b.** Copy the triangle and *translate* (or slide) it to form a new figure, called an *image*, $\triangle A'B'C'$. (read as "triangle $A$ prime, $B$ prime, $C$ prime").

**c.** What is the relationship between the coordinates of the vertices of $\triangle ABC$ and those of $\triangle A'B'C'$?

**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.**

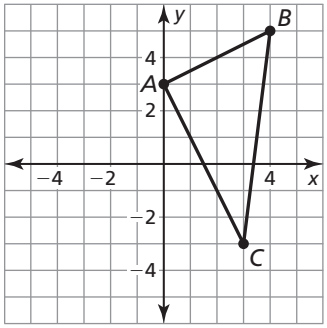
**Work with a partner.**

**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.

## 3 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, $\triangle ABC$?

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# 4.1 Notetaking with Vocabulary

**For use after Lesson 4.1**

**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

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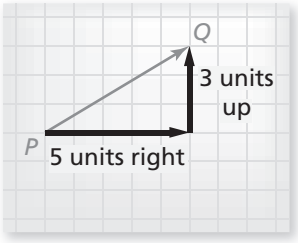
## 4.1 Notetaking with Vocabulary (continued)

## 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 $\langle 5, 3 \rangle$.

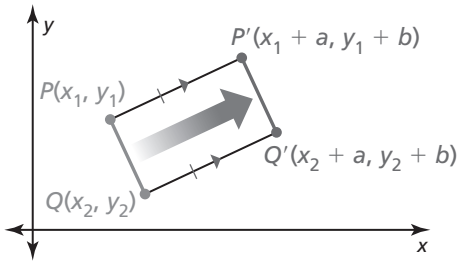



**Notes:**

### 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.

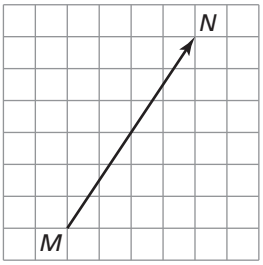
- $PP' = QQ'$ and $\overline{PP'} \parallel \overline{QQ'}$, or
- $PP' = QQ'$ and $\overline{PP'}$ and $\overline{QQ'}$ are collinear.

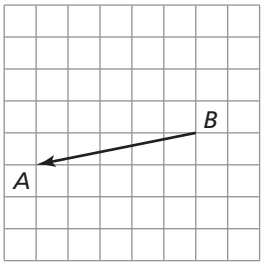


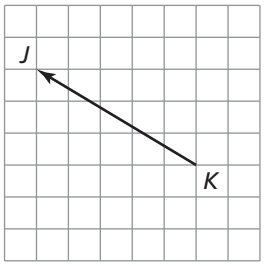

**Notes:**

## Extra Practice

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

1. 


2. 


3. 

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## 4.1 Notetaking with Vocabulary (continued)

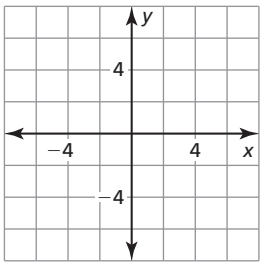
**In Exercises 4–7, the vertices of $\triangle ABC$ are $A(1, 2)$, $B(5, 1)$, $C(5, 4)$. Translate $\triangle ABC$ using the given vector. Graph $\triangle ABC$ and its image.**

**4.** $\langle -4, 0 \rangle$

**5.** $\langle -2, -4 \rangle$

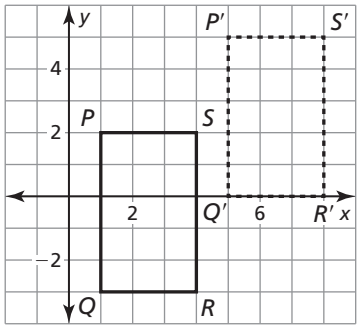
**6.** $\langle 0, -5 \rangle$

**7.** $\langle 1, -3 \rangle$

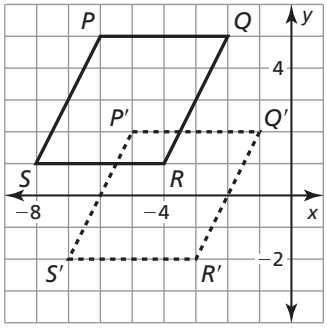



**In Exercises 8 and 9, write a rule for the translation of quadrilateral *PQRS* to quadrilateral *P′Q′R′S′*.**

**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.