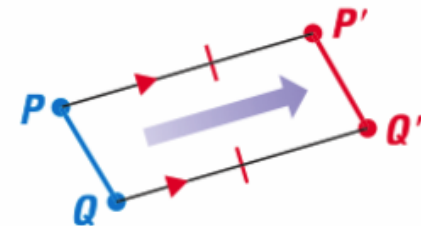


# 9.1 Translate Figures and Use Vectors

In Lesson 4.8, you learned that a *transformation* moves or changes a figure in some way to produce a new figure called an **image**. Another name for the original figure is the **preimage**.

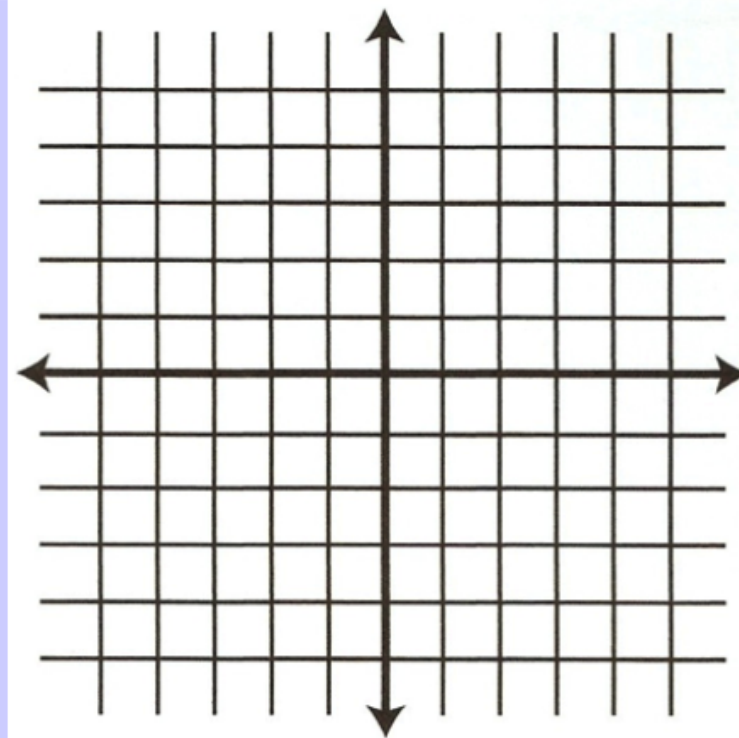
Recall that a *translation* moves every point of a figure the same distance in the same direction. More specifically, a translation maps, or moves, the points  $P$  and  $Q$  of a plane figure to the points  $P'$  (read “ $P$  prime”) and  $Q'$ , so that one of the following statements is true:

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



**EXAMPLE 1** Translate a figure in the coordinate plane

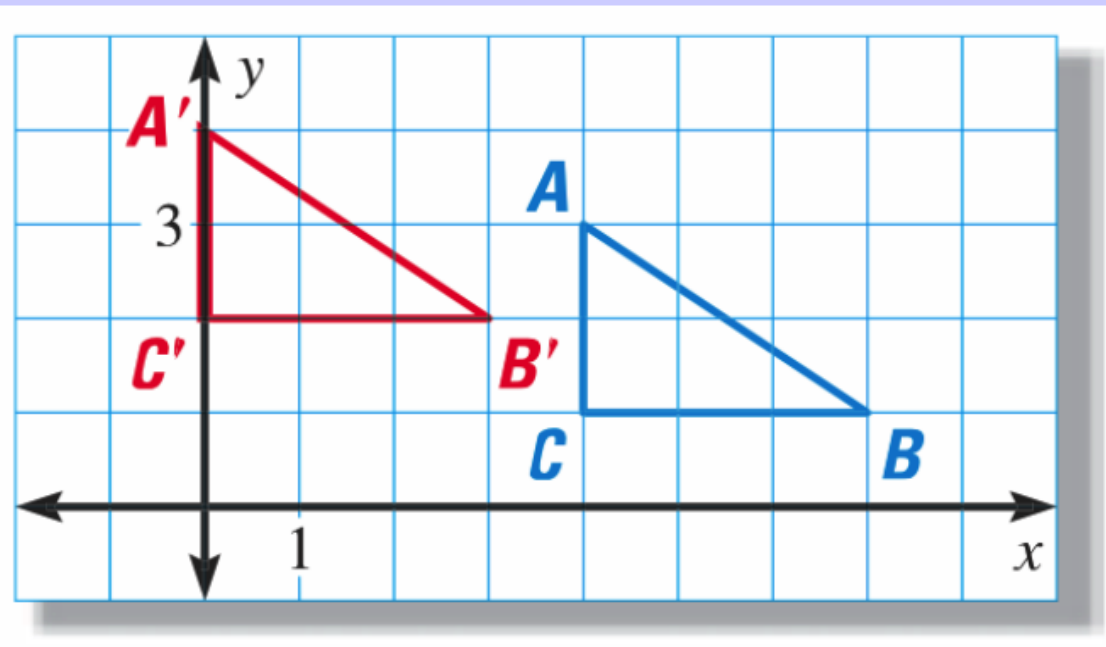
Graph quadrilateral  $ABCD$  with vertices  $A(-1, 2)$ ,  $B(-1, 5)$ ,  $C(4, 6)$ , and  $D(4, 2)$ . Find the image of each vertex after the translation  $(x, y) \rightarrow (x + 3, y - 1)$ . Then graph the image using prime notation.



**ISOMETRY** An **isometry** is a transformation that preserves length and angle measure. Isometry is another word for congruence transformation (page 272).

**EXAMPLE 2** Write a translation rule and verify congruence

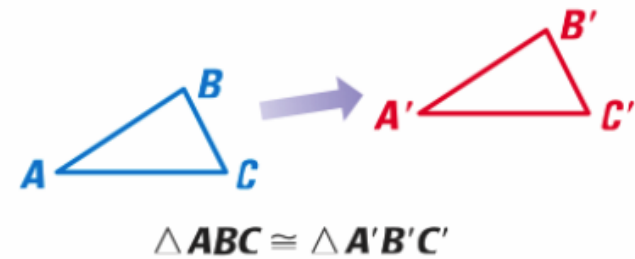
Write a rule for the translation of  $\triangle ABC$  to  $\triangle A'B'C'$ . Then verify that the transformation is an isometry.



**THEOREM***For Your Notebook***THEOREM 9.1 Translation Theorem**

A translation is an isometry.

*Proof:* below; Ex. 46, p. 579



**VECTORS** Another way to describe a translation is by using a vector. A **vector** is a quantity that has both direction and *magnitude*, or size. A vector is represented in the coordinate plane by an arrow drawn from one point to another.

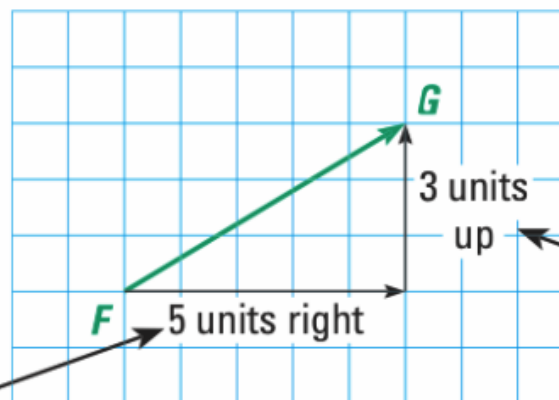
## KEY CONCEPT

*For Your Notebook*

### Vectors

The diagram shows a vector named  $\overrightarrow{FG}$ , read as “vector  $FG$ .”

The **initial point**, or starting point, of the vector is  $F$ .



The **terminal point**, or ending point, of the vector is  $G$ .

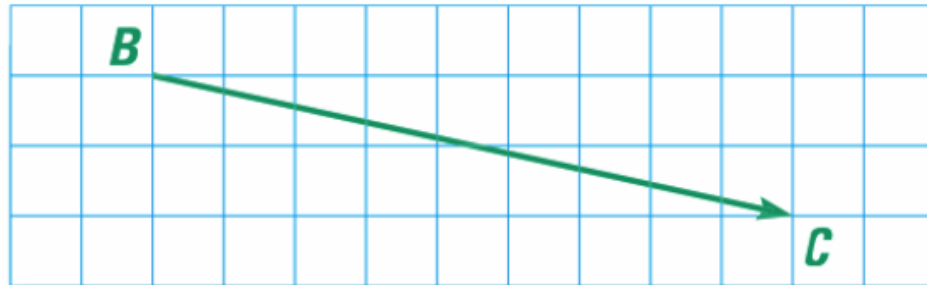
**horizontal component**

**vertical component**

The **component form** of a vector combines the horizontal and vertical components. So, the component form of  $\overrightarrow{FG}$  is  $\langle 5, 3 \rangle$ .

**EXAMPLE 3** Identify vector components

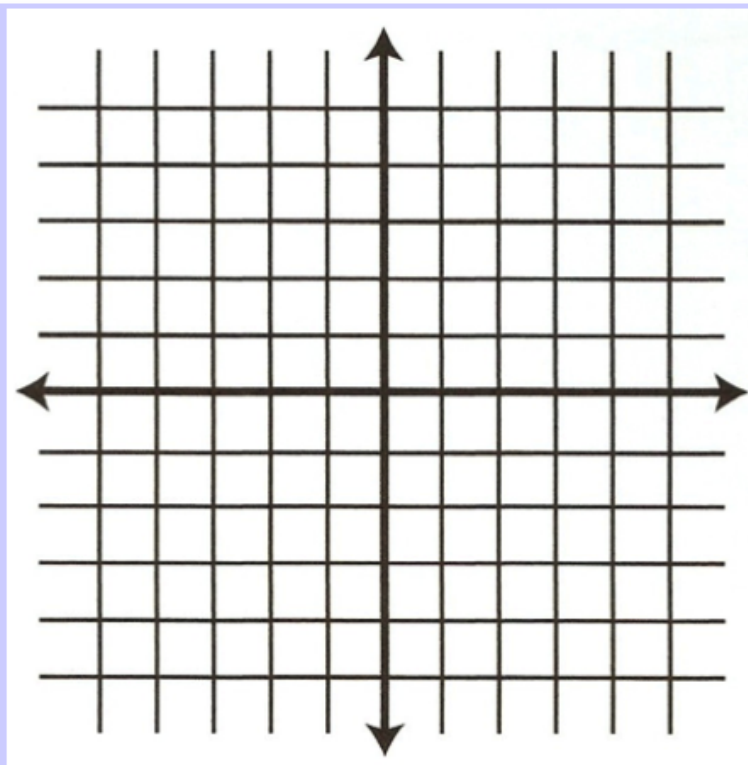
Name the vector and write its component form.

**a.****b.**



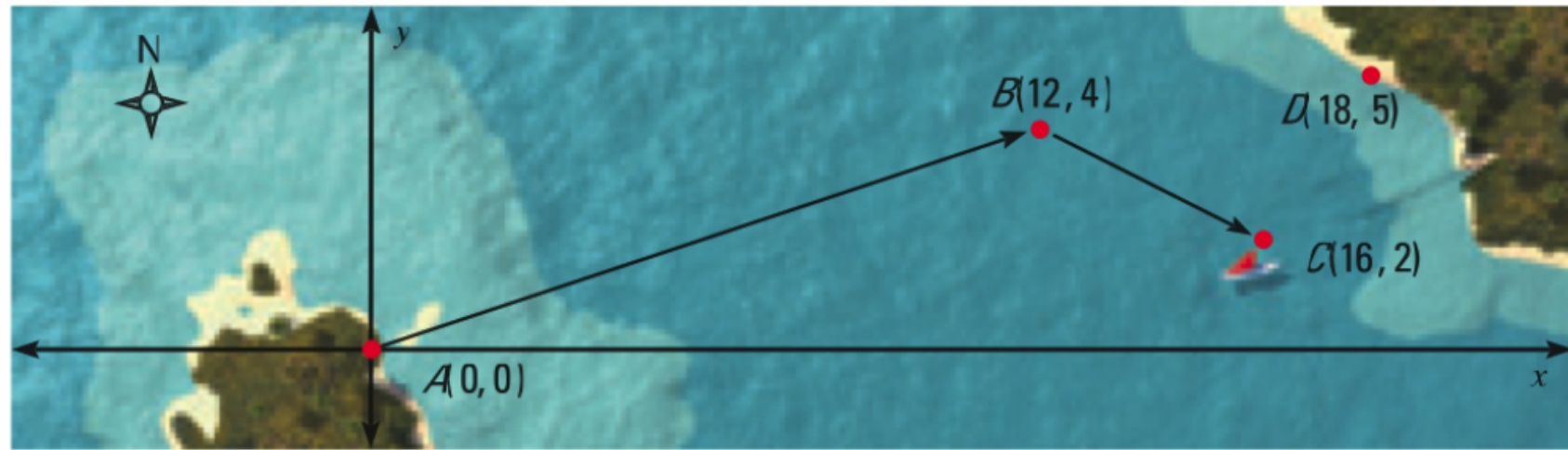
**EXAMPLE 4** Use a vector to translate a figure

The vertices of  $\triangle ABC$  are  $A(0, 3)$ ,  $B(2, 4)$ , and  $C(1, 0)$ . Translate  $\triangle ABC$  using the vector  $\langle 5, -1 \rangle$ .



**EXAMPLE 5** Solve a multi-step problem

**NAVIGATION** A boat heads out from point  $A$  on one island toward point  $D$  on another. The boat encounters a storm at  $B$ , 12 miles east and 4 miles north of its starting point. The storm pushes the boat off course to point  $C$ , as shown.



- Write the component form of  $\overrightarrow{AB}$ .
- Write the component form of  $\overrightarrow{BC}$ .
- Write the component form of the vector that describes the straight line path from the boat's current position  $C$  to its intended destination  $D$ .

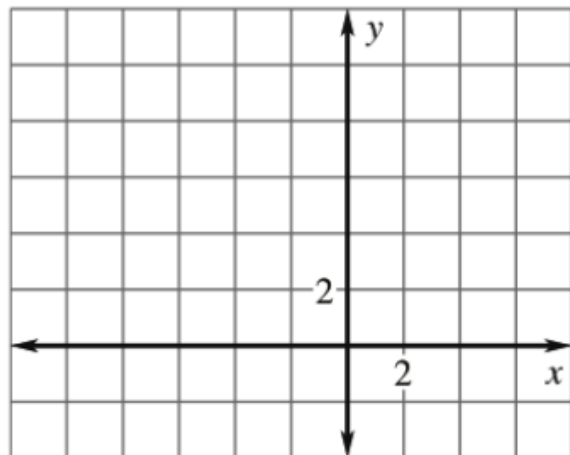
**Assignment:**  
**9.1 worksheet**

**LESSON**  
**9.1****Practice***For use with pages 572–579***Use the translation  $(x, y) \rightarrow (x + 6, y - 3)$ .**

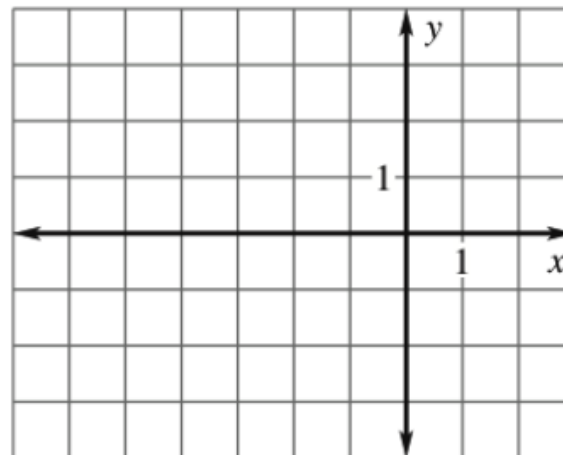
1. What is the image of  $A(3, 2)$ ?
2. What is the image of  $B(-4, 1)$ ?
3. What is the preimage of  $C'(2, -7)$ ?
4. What is the preimage of  $D'(-3, -2)$ ?

**The vertices of  $\triangle ABC$  are  $A(-1, 1)$ ,  $B(4, -1)$ , and  $C(2, 4)$ . Graph the image of the triangle using prime notation.**

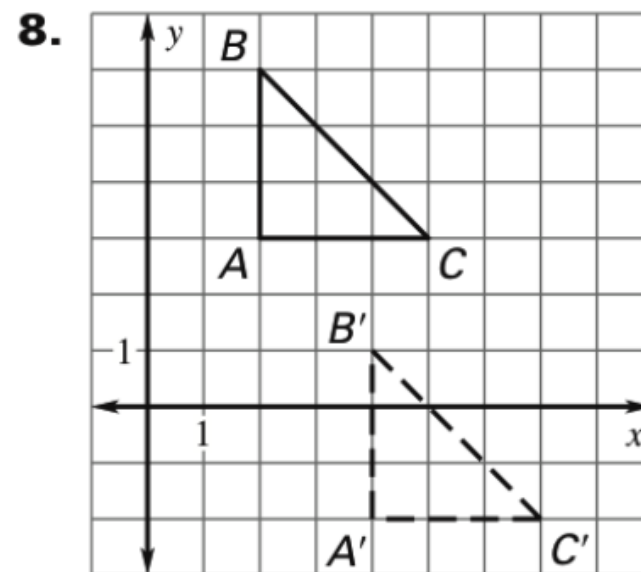
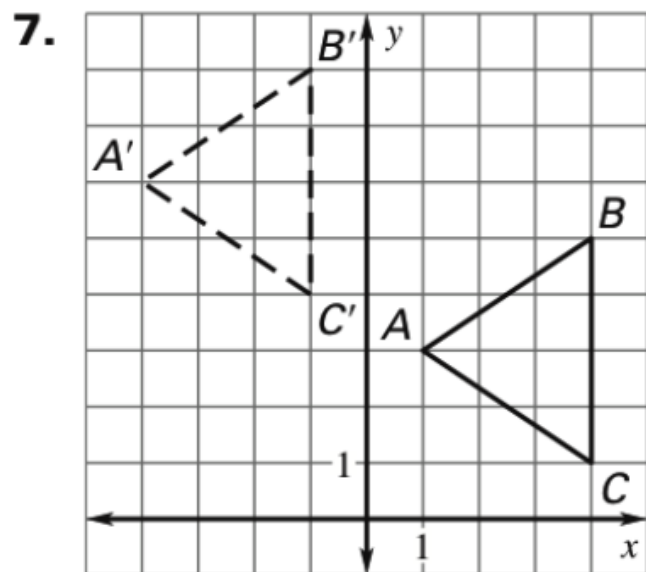
**5.**  $(x, y) \rightarrow (x - 3, y + 5)$



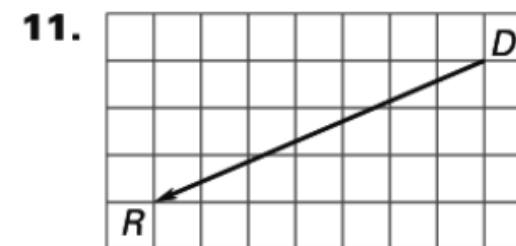
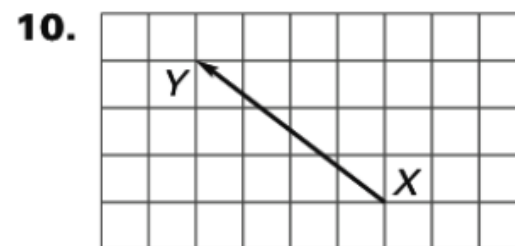
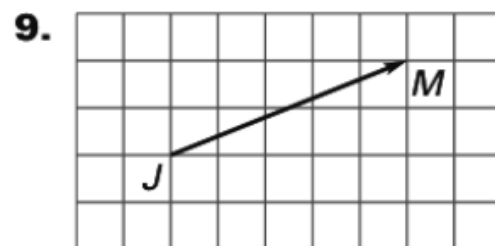
**6.**  $(x, y) \rightarrow (x - 4, y - 2)$



$\triangle A'B'C'$  is the image of  $\triangle ABC$  after a translation. Write a rule for the translation. Then verify that the translation is an isometry.



**Name the vector and write its component form.**



**Use the point  $P(5, -2)$ . Find the component form of the vector that describes the translation to  $P'$ .**

**12.**  $P'(2, 0)$

**13.**  $P'(8, -3)$

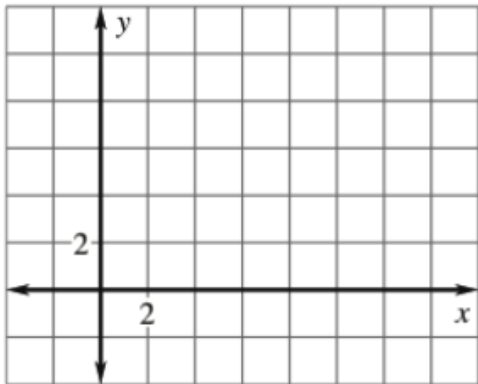
**14.**  $P'(0, 4)$

**15.**  $P'(-5, -4)$

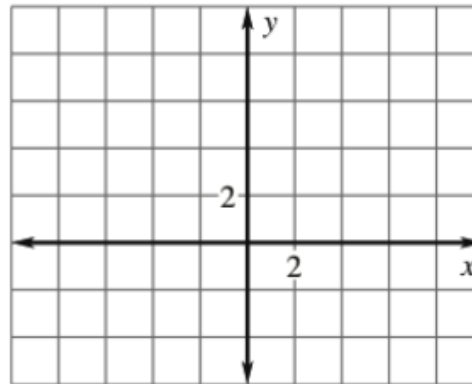


The vertices of  $\triangle ABC$  are  $A(1, 2)$ ,  $B(2, 6)$ , and  $C(3, 1)$ . Translate  $\triangle ABC$  using the given vector. Graph  $\triangle ABC$  and its image.

16.  $\langle 8, 2 \rangle$

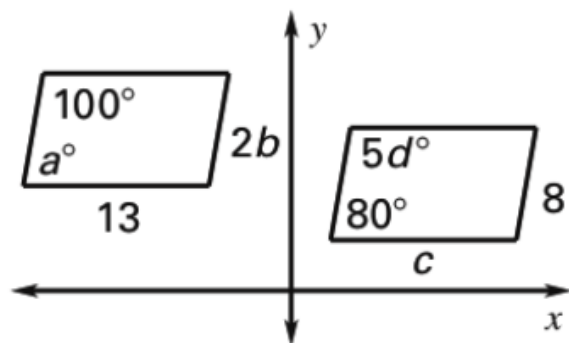


17.  $\langle -7, -3 \rangle$

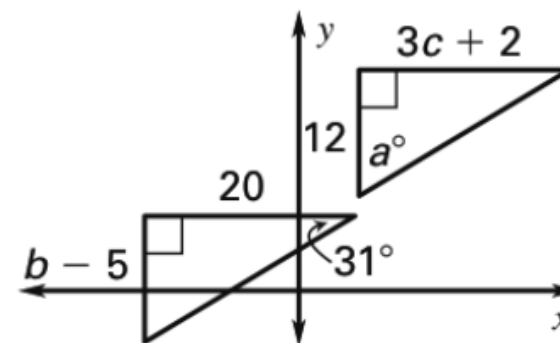


**Find the value of each variable in the translation.**

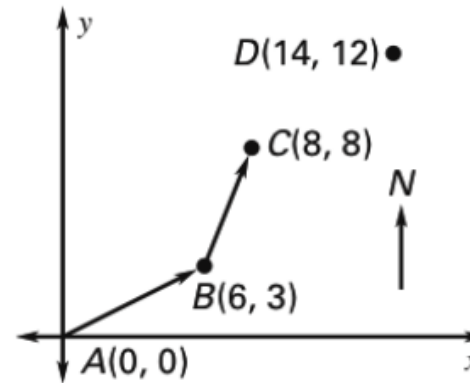
**18.**



**19.**



**20. Navigation** A hot air balloon is flying from point  $A$  to point  $D$ . After the balloon travels 6 miles east and 3 miles north, the wind direction changes at point  $B$ . The balloon travels to point  $C$  as shown in the diagram.



**a.** Write the component form for  $\overrightarrow{AB}$  and  $\overrightarrow{BC}$ .

**b.** The wind direction changes and the balloon travels from point  $C$  to point  $D$ . Write the component form for  $\overrightarrow{CD}$ .

**c.** What is the total distance the balloon travels?

**d.** Suppose the balloon went straight from  $A$  to  $D$ . Write the component form of the vector that describes this path. What is this distance?