**Vectors:**

*x*

*y*

0

1

2

3

4

5

6

1

2

3

4

5

6

*A*

*A’*



##### A **vector** is any quantity that has magnitude and direction. Vectors usually describe how far and in what direction an object has moved from one location to another. For example, the car in the figure starts its position at point (1, 1) and moves to point (4, 5). The vector that describes the movement can be described by the horizontal movement and the vertical movement from point A to point A’. We subtract the *x*-values and the *y-*values.

##### **v** = [4 – 1, 5 – 1] = [3, 4]

##### So the car ended up moving 3 units to the right and 4 units up to get to its new position at A’.

##### We call this **ordered pair notation** and vector **v** is called the **position vector**. Movement to the right or up has a positive value, while movement to the left or down has negative value.

**Example 1 :** Describe vector AB using ordered pair notation.

**Solution:**

The vector starts at the

origin: point (0, 0)

and moves to point (3, -4).

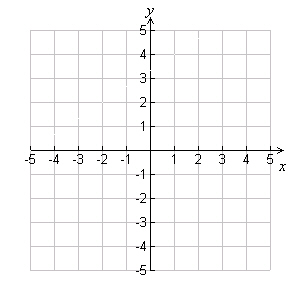
Vector AB = [3, -4]

**Example 2 :** Vector **v** has initial point P= (-1, 4) and terminal point Q = (3, -2). Find the position vector.

**Solution:**

To find the position vector, we subtract the P values from the Q values.

Vector **v** = [3 – (-1), -2 – 4] = [4, -6]

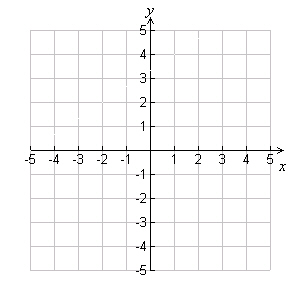
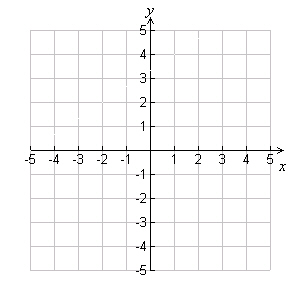
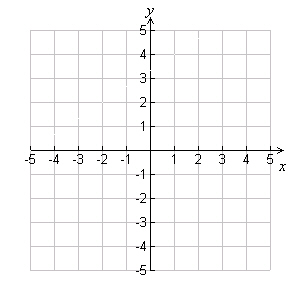


A

B

##### **Practice Problems:**

##### Describe each vector in ordered pair notation:



##### 1. 2. 3.

##### The vector **v** has initial point P and terminal point Q. Find the position vector.

4. P = (0,0); Q = (3,4) 5. P = (0,0); Q = (-3,-5) 6. P = (3,2); Q = (5,6)

7. P = (-3,2); Q = (6,5) 8. P = (-2,-1); Q = (6,-2) 9. P = (-1,4); Q = (6,2)

10. P = (0,0,0); Q = (3,4,-1) 11. P = (3,2,-1); Q = (5,6,0) 12. P = (-3,2,0); Q = (6,5,-1)

##### **Magnitude and Direction**

*x*

*y*

0

1

2

3

4

5

6

1

2

3

4

5

6

*A*

*A’*



x = 3

y = 4

D=|**v**|

θ

##### Another way to describe a vector is by its magnitude and direction. The **magnitude** of the vector that describes the movement of the car from point A to point A’ is the distance between these two points. The magnitude can be found by using the Pythagorean Theorem:

##### 

##### This means that the car moves five units in a straight line to get from point A to point B.

##### The direction is given by the angle θ which is the angle that the vector makes with the horizontal. We use the tangent ratio to find θ:

##### 

In general, if we have the ordered pair notation for a vector **v** = (x, y)

The magnitude of vector **v** is given by: 

And the direction of vector **v** is given by: 

On the other hand, if we know the magnitude and direction of a vector, we can find the x and y values of the position vector.

We can see from the figure above, that and .

Therefore,and 

**Example 1 :** What is themagnitude and direction of vector AB?

**Solution:**

We draw a right triangle

with its hypotenuse being

the vector v and its

legs along the vertical

and horizontal directions.

Then 



**Example 2 :** A vector **v** has magnitude of 4 and direction . Find the ordered pair notation of the vector.

**Solution:**

Draw the vector **v** starting at the origin.

We need to measure and angle

of 30o from the positive *x*-axis and

then measure 4 units along a line

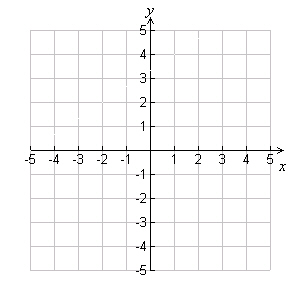
drawn from the origin along that angle.

Then,





So, **v** = [3.5, 2]

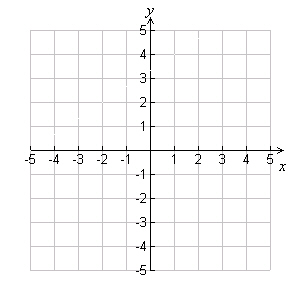


A

B

θ

|**v**|



x

y

30o

4

**Practice problems:**

1. Find the magnitude and direction of the following vectors:

a. **v** = [4, 5] b. **v** = [-6, 2] c. **v** = [1, -4] d. **v** = [-8, -4]

e. **v** = [9, -6] f. **v** = [10, 7] g. **v** = [8, -5] h. **v** = [-12, -8]

2. Find the ordered pair notation for the vectors with the following magnitudes and directions.

a. |**v** |= 4, θ = 20o b. |**v** |= 6, θ = 55o c. |**v** |= 10, θ = 30o west of north

e. |**v** |= 12, θ = 45o east of south f. |**v** |= 9, θ = 60o west of south

**Transformations:**

##### Geometrical transformations change the positions, or sizes, of shapes on a plane in particular ways. You will learn about four basic ways of changing the position and size of shapes: **translation, reflection, rotation** and **enlargement.**

##### All of these transformations, except enlargement, keep a shape congruent with itself.

##### **Translation**

##### Translation is the movement of a shape from one place to another without reflecting it or rotating it. It is sometimes called a **glide**, since the shape seems to glide from one place to another. Every point in the shape moves in the same direction and through the same distance.

*x*

*y*

0

1

2

3

4

5

6

1

2

3

4

5

6

*A*

*B*

*C*

*D*

We describe such changes in position using vectors.

In such a vector, the move from one point to another is represented by the combination of a horizontal shift and a vertical shift.

In the figure to the left:

The vector describing the translation from A to B is (2, 1)

The vector describing the translation from B to C is (2, 0)

The vector describing the translation from C to D is (-3, 2)

The vector describing the translation from D to A is (-1, -3)

**Notice**

The first number describes the horizontal movement

The second number describes the vertical movement.

**1**. Describe the following translations with vectors in the figure to the left:

**a**. *A* to *B* **b.** *A* to *F* **c.** *B* to *D* **d.** *B* to *C*

**e**. *C* to *B* **f.** *C* to *E* **g.** *D* to *B* **h.** *D*  to *A*

**i.** *E* to *G* **j.** *E* to *F* **k.** *F* to *B* **l.** *F* to *G*

**m**. *G* to *C* **n.** *G* to *B*

**2**. **a.** Draw a triangle with coordinates A(1, 1), B(2, 1) and C(1, 3).

**b.** Draw the image ABC after a translation with vector (2, 3). Label this P.

**c.** Draw the image ABC after a translation with vector (-1, 2). Label this Q.

**d.** Draw the image ABC after a translation with vector (3, -2). Label this R.

**e.** Draw the image ABC after a translation with vector (-2, -4). Label this S.

**3**. Using the diagram from question 2, write the translation vector that moves:

**a.** *P* to *Q* **b.** *Q* to *R* **c.** *R* to *S* **d.** *S* to *P*

**e.** *R* to *P* **f.** *S* to *Q* **g.** *R* to *Q* **h.** *P* to *S*

##### **Practice Problems:**

*x*

*y*

0

1

2

3

4

5

6

1

2

3

4

5

6

*A*

7

8

7

8

*B*

*C*

*D*

*E*

*F*

*G*

**Reflection**

Reflection is the movement of a shape so that it becomes a mirror image of itself.

For example:

object

image

Mirror line

Notice the reflection of each point in the original shape is perpendicular to the mirror line. So if you fold the whole diagram along the mirror line, any object point will coincide with its reflection.

**Practice Problems:**

Draw the reflection of each figure in the given mirror line.

**a. b. c.**

d. e.

h.

f. g.

i. j.