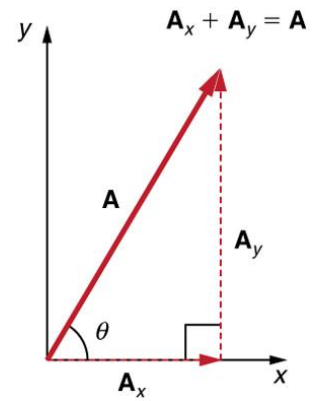


**Vectors**

- Vectors are measurements with \_\_\_\_\_ and \_\_\_\_\_.
  - They are represented by \_\_\_\_\_.
  - The length of the arrow is the \_\_\_\_\_.
  - The direction of the arrow is the \_\_\_\_\_.
- Can be represented in \_\_\_\_\_ form
  - Make a \_\_\_\_\_ using the vector as the \_\_\_\_\_
  - Use \_\_\_\_\_ and \_\_\_\_\_ to find the horizontal (x) component and the vertical (y) component
  - Assign \_\_\_\_\_ signs to any component going \_\_\_\_\_ or \_\_\_\_\_
- $\sin(\theta) = \frac{\text{opposite}}{\text{hypotenuse}}$        $\cos(\theta) = \frac{\text{adjacent}}{\text{hypotenuse}}$        $\tan(\theta) = \frac{\text{opposite}}{\text{adjacent}}$



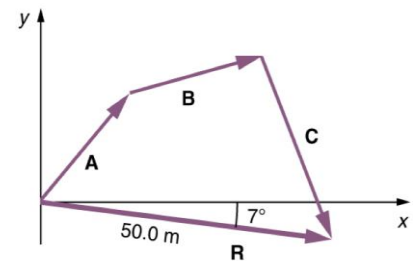
A football player kicks a ball at 15 m/s at 30° above the ground. Find the horizontal and vertical components of this velocity.

**Scalar Multiplication**

- Multiplying a vector by a \_\_\_\_\_ number
- Draw the vector that many times in a \_\_\_\_\_
- Or multiply the \_\_\_\_\_ by that number
- A negative vector means multiply by -1, so it goes in the \_\_\_\_\_ direction

**Vector Addition - Graphical Method**

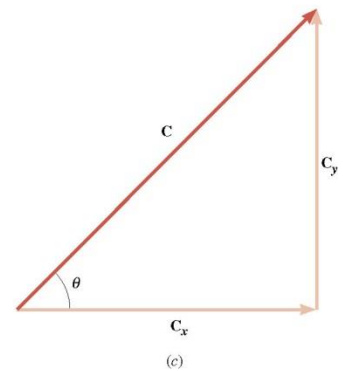
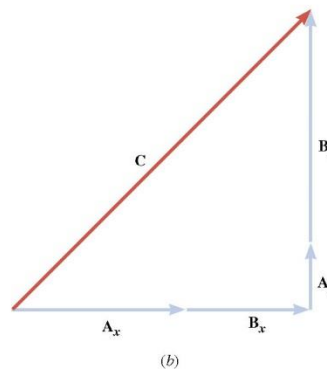
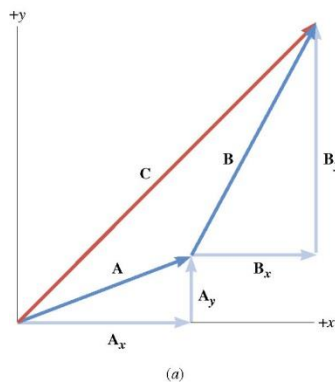
- Draw the \_\_\_\_\_ vector.
- Draw the second vector where the \_\_\_\_\_ (tip-to-tail).
- Draw the resultant vector from where the \_\_\_\_\_ vector begins to where the \_\_\_\_\_ vector ends.
- \_\_\_\_\_ the resultant's length and direction.



Add the following vectors graphically.  $A = 2\sqrt{2}$  at 45° N of E,  $B = 2\sqrt{2}$  at 45° W of N.

**Vector Addition - Component Method**

Vectors can be described by its \_\_\_\_\_ to show how far it goes in the x and y directions. To add vectors, you simply add the \_\_\_\_\_ and \_\_\_\_\_ to get total (\_\_\_\_\_ ) x and y components.



1. Find the \_\_\_\_\_ for \_\_\_\_\_ the vectors to be added
2. \_\_\_\_\_ all the \_\_\_\_\_ components
3. \_\_\_\_\_ all the \_\_\_\_\_ components
4. Use the \_\_\_\_\_ Theorem to find the \_\_\_\_\_ of the resultant
5. Use \_\_\_\_\_ to find the \_\_\_\_\_ (the direction is always found at the \_\_\_\_\_ of the resultant)

Note: Drawing pictures and triangles helps immensely.

Add the follow vectors.  $C = 15\text{ m}$  at  $25^\circ\text{ N of E}$ ;  $D = 20\text{ m}$  at  $60^\circ\text{ S of E}$

A jogger runs  $145\text{ m}$  in a direction  $20.0^\circ$  east of north and then  $105\text{ m}$  in a direction  $35.0^\circ$  south of east. Determine the magnitude and direction of jogger's position from her starting point.

**Homework**

- (a) Is it possible for one component of a vector to be zero, while the vector itself is not zero? (b) Is it possible for a vector to be zero, while one component is not zero? Explain.
- Can two nonzero perpendicular vectors be added together so their sum is zero? Explain.
- Can three or more vectors with unequal magnitudes be added together so their sum is zero? If so, show by means of a tip-to-tail arrangement of the vectors how this could occur.
- Suppose you first walk  $12.0\text{ m}$  in a direction  $20^\circ$  west of north and then  $20.0\text{ m}$  in a direction  $40.0^\circ$  south of west. How far are you from your starting point, and what is the compass direction of a line connecting your starting point to your final position? Solve this graphically. (OpenStax 3.5)  **$19.5\text{ m}$  at  $4.65^\circ\text{ S of W}$**
- An ostrich is running at a speed of  $17.0\text{ m/s}$  in a direction of  $68.0^\circ$  north of west. What is the magnitude of ostrich's velocity component that is directed (a) due north and (b) due west? (RW)  **$15.8\text{ m/s}$ ,  $6.37\text{ m/s}$**
- An ocean liner leaves New York City and travels  $18.0^\circ$  north of east for  $155\text{ km}$ . How far east and how far north has it gone? In other words, what are the magnitudes of the components of the ship's displacement vector in the directions (a) due east and (b) due north? (Cutnell 1.33)  **$147\text{ km}$ ,  $47.9\text{ km}$**
- A new landowner has a triangular piece of flat land she wishes to fence. Starting at the west corner, she measures the first side to be  $80.0\text{ m}$  long and the next to be  $105\text{ m}$ . These sides are represented as displacement vectors  $A$  and  $B$  in Figure 3.61. She then correctly calculates the length and orientation of the third side  $C$ . What is her result? (Hint: Since  $A + B + C = 0$ , then  $A + B = -C$ .) (OpenStax 3.20)  **$92.3\text{ m}$  at  $53.7^\circ\text{ S of W}$**
- A golfer, putting on a green, requires three strokes to "hole the ball." During the first putt, the ball rolls  $5.0\text{ m}$  due east. For the second putt, the ball travels  $2.1\text{ m}$  at an angle of  $20.0^\circ$  north of east. The third putt is  $0.50\text{ m}$  due north. What displacement (magnitude and direction relative to due east) would have been needed to "hole the ball" on the very first putt? (Cutnell 1.41)  **$7.1\text{ m}$  at  $9.9^\circ\text{ N of E}$**
- You are on a treasure hunt and your map says, "Walk due west for 52 paces, then walk  $30.0^\circ$  north of west for 42 paces, and finally walk due north for 25 paces." What is the magnitude of the component of your displacement (a) due north and (b) due west? (Cutnell 1.42)  **$46\text{ paces}$ ,  $88\text{ paces}$**
- On a safari, a team of naturalists sets out toward a research station located  $4.8\text{ km}$  away in a direction  $42^\circ$  north of east. After traveling in a straight line for  $2.4\text{ km}$ , they stop and discover that they have been traveling  $22^\circ$  north of east, because their guide misread his compass. What are (a) the magnitude and (b) the direction (relative to due east) of the displacement vector now required to bring the team to the research station? (Cutnell 1.45)  **$2.7\text{ km}$  at  $60^\circ\text{ N of E}$**
- While snorkeling in the ocean, you swim directly towards shore at  $2\text{ m/s}$ . The current of the water pushes you directly sideways at  $3\text{ m/s}$ . What is your resultant velocity (magnitude and direction relative to your intended path of straight towards shore)? (RW)  **$3.6\text{ m/s}$  at  $56.3^\circ$**
- An airplane flies at  $200\text{ km/h}$  at  $30.0^\circ\text{ N of W}$ . The wind blows it at  $30\text{ km/h}$  at  $45.0^\circ\text{ E of N}$ . What is the resultant velocity of the airplane (magnitude and direction)? (RW)  **$194\text{ km/h}$  at  $38.6^\circ\text{ N of W}$**
- You are trying to row a boat directly across a river that is  $50.0\text{ m}$  wide. You can row at  $3.1\text{ m/s}$  in a direction directly across the river perpendicular to the shore. The current is  $4.8\text{ m/s}$  parallel to shore. (a) What is your velocity relative to the shore? (b) How much time does it take to get to the other side of the river? (c) How far down stream do you land? (RW)  **$5.71\text{ m/s}$  at  $32.9^\circ$  downstream from shore,  $16.1\text{ s}$ ,  $77.7\text{ m}$**

