If we know A_x and A_y, we can find the angle θ from

$$\tan\theta = \frac{A_y}{A_x}, \qquad \theta = \tan^{-1}\frac{A_y}{A_x} \tag{3-4}$$

and the magnitude A from the Pythagorean theorem:

$$A = \sqrt{A_x^2 + A_y^2} \tag{3-5a}$$

In three dimensions,

$$A = \sqrt{A_x^2 + A_y^2 + A_z^2} \tag{3-5b}$$

Components can be positive or negative. For example, if $\vec{A}$ points in the negative x direction, A_x is negative. Consider two vectors $\vec{A}$ and $\vec{B}$ that lie in the xy plane. The rectangular components of each vector and those of the sum $\vec{C} = \vec{A} + \vec{B}$ are shown in Figure 3-9. We see that $\vec{C} = \vec{A} + \vec{B}$ is equivalent to both

$$C_x = A_x + B_x \tag{3-6a}$$

and

$$C_y = A_y + B_y \tag{3-6b}$$

Exercise A car travels 20 km in a direction 30° north of west. Let the x axis point east and the y axis point north as in Figure 3-10. Find the x and y components of the displacement vector of the car. (*Answer* $A_x = -17.3$ km, $A_y = +10$ km)

Figure 3-9

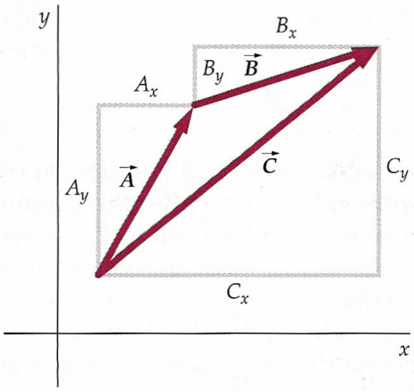
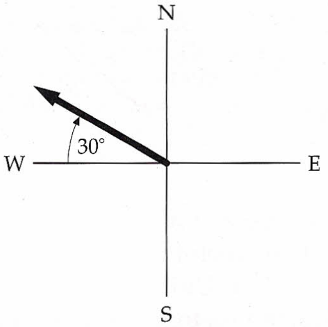


Figure 3-10

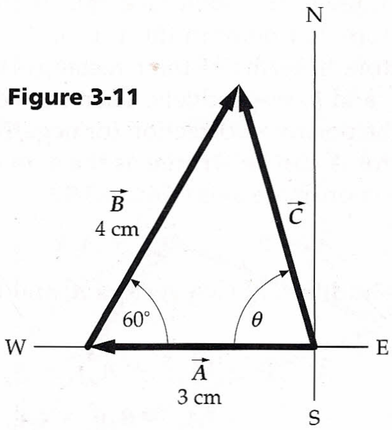


Example 3-2

You walk 3 km west and then 4 km headed 60° north of east (Figure 3-11). Find your resultant displacement (*a*) graphically and (*b*) using vector components.

Picture the Problem The triangle formed by the three vectors is not a right triangle, so the magnitudes of the vectors are not related by the Pythagorean theorem. We find the resultant graphically by drawing each of the displacements to scale and measuring the resultant displacement.

Figure 3-11



(*a*) If we draw the first displacement vector 3 cm long and the second one 4 cm long, we find the resultant vector to be about 3.5 cm long. Thus, the magnitude of the resultant displacement is 3.5 km. The angle θ