RESOLVING VECTORS INTO COMPONENTS

components of a vector

the projections of a vector along the axes of a coordinate system

In the pyramid example, the horizontal and vertical parts that add up to give the tourist's actual displacement are called **components.** The *x* component is parallel to the *x*-axis. The *y* component is parallel to the *y*-axis. Any vector can be completely described by a set of perpendicular components.

In this textbook, components of vectors are shown as outlined, open arrows. Components have arrowheads to indicate their direction. Components are scalars (numbers), but they are signed numbers, and the direction is important to determine their sign in a particular coordinate system.

You can often describe an object's motion more conveniently by breaking a single vector into two components, or *resolving* the vector. Resolving a vector allows you to analyze the motion in each direction.

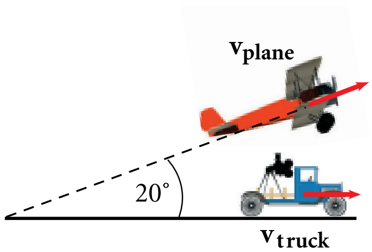

Figure 10
A truck carrying a film crew must be driven at the correct velocity to enable the crew to film the underside of a biplane. The plane flies at 95 km/h at an angle of 20° relative to the ground.

This point may be illustrated by examining a scene on the set of a new action movie. For this scene, a biplane travels at 95 km/h at an angle of 20° relative to the ground. Attempting to film the plane from below, a camera team travels in a truck that is directly beneath the plane at all times, as shown in **Figure 10.**

To find the velocity that the truck must maintain to stay beneath the plane, we must know the horizontal component of the plane's velocity. Once more, the key to solving the problem is to recognize that a right triangle can be drawn using the plane's velocity and its *x* and *y* components. The situation can then be analyzed using trigonometry.

The sine and cosine functions are defined in terms of the lengths of the sides of such right triangles. The sine of an angle is the ratio of the leg opposite that angle to the hypotenuse.

DEFINITION OF THE SINE FUNCTION FOR RIGHT TRIANGLES

$$\sin\theta = \frac{opp}{hyp} \qquad \textbf{sine of an angle} = \frac{\textbf{opposite leg}}{\textbf{hypotenuse}}$$

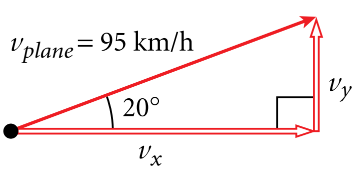

Figure 11
To stay beneath the biplane, the truck must be driven with a velocity equal to the *x* component (v_x) of the biplane's velocity.

In **Figure 11,** the leg opposite the 20° angle represents the *y* component, v_y, which describes the vertical speed of the airplane. The hypotenuse, $\mathbf{v}_{plane}$, is the resultant vector that describes the airplane's total velocity.

The cosine of an angle is the ratio between the leg adjacent to that angle and the hypotenuse.

DEFINITION OF THE COSINE FUNCTION FOR RIGHT TRIANGLES

$$\cos\theta = \frac{adj}{hyp} \qquad \textbf{cosine of an angle} = \frac{\textbf{adjacent leg}}{\textbf{hypotenuse}}$$

In **Figure 11,** the adjacent leg represents the *x* component, v_x, which describes the airplane's horizontal speed. This *x* component equals the speed that the truck must maintain to stay beneath the plane. Thus, the truck must maintain a speed of $v_x = (\cos 20°)(95 \text{ km/h}) = 90$ km/h.