SECTION 4

Relative Motion

SECTION OBJECTIVES

- Describe situations in terms of frame of reference.
- Solve problems involving relative velocity.

FRAMES OF REFERENCE

If you are moving at 80 km/h north and a car passes you going 90 km/h, to you the faster car seems to be moving north at 10 km/h. Someone standing on the side of the road would measure the velocity of the faster car as 90 km/h toward the north. This simple example demonstrates that velocity measurements depend on the frame of reference of the observer.

Velocity measurements differ in different frames of reference

Observers using different frames of reference may measure different displacements or velocities for an object in motion. That is, two observers moving with respect to each other would generally not agree on some features of the motion.

Consider a stunt dummy that is dropped from an airplane flying horizontally over Earth with a constant velocity. As shown in **Figure 19(a),** a passenger on the airplane would describe the motion of the dummy as a straight line toward Earth. An observer on the ground would view the trajectory of the dummy as that of a projectile, as shown in **Figure 19(b).** Relative to the ground, the dummy would have a vertical component of velocity (resulting from free-fall acceleration and equal to the velocity measured by the observer in the airplane) *and* a horizontal component of velocity given to it by the airplane's motion. If the airplane continued to move horizontally with the same velocity, the dummy would enter the swimming pool directly beneath the airplane (assuming negligible air resistance).

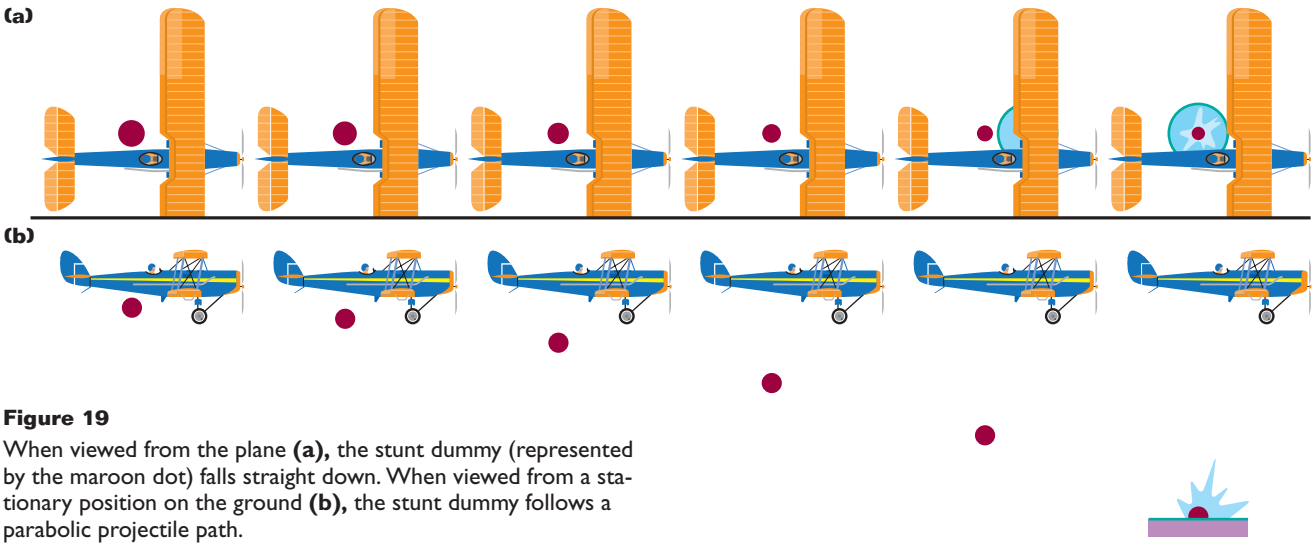

Figure 19
When viewed from the plane **(a),** the stunt dummy (represented by the maroon dot) falls straight down. When viewed from a stationary position on the ground **(b),** the stunt dummy follows a parabolic projectile path.