PRACTICE F

Falling Object

1. A robot probe drops a camera off the rim of a 239 m high cliff on Mars, where the free-fall acceleration is $-3.7\ m/s^2$.
   - **a.** Find the velocity with which the camera hits the ground.
   - **b.** Find the time required for it to hit the ground.
2. A flowerpot falls from a windowsill 25.0 m above the sidewalk.
   - **a.** How fast is the flowerpot moving when it strikes the ground?
   - **b.** How much time does a passerby on the sidewalk below have to move out of the way before the flowerpot hits the ground?
3. A tennis ball is thrown vertically upward with an initial velocity of +8.0 m/s.
   - **a.** What will the ball's speed be when it returns to its starting point?
   - **b.** How long will the ball take to reach its starting point?
4. Calculate the displacement of the volleyball in Sample Problem F when the volleyball's final velocity is 1.1 m/s upward.

Why it Matters

Sky Diving

When these sky divers jump from an airplane, they plummet toward the ground. If Earth had no atmosphere, the sky divers would accelerate with the free-fall acceleration, *g*, equal to $9.81\ m/s^2$. They would not slow down even after opening their parachutes. Fortunately, Earth does have an atmosphere, and the acceleration of the sky divers does not remain constant. Instead, because of air resistance, the acceleration decreases as they fall. After a few seconds, the acceleration drops to zero and the speed becomes constant. The constant speed an object reaches when falling through a resisting medium is called *terminal velocity*.

The terminal velocity of an object depends on the object's mass, shape, and size. When a sky diver is spread out horizontally to the ground, the sky diver's terminal velocity is typically about 55 m/s (123 mi/h). If the sky diver curls into a ball, the terminal velocity may increase to close to 90 m/s (200 mi/h). When the sky diver opens the parachute, air resistance increases, and the sky diver decelerates to a new, slower terminal velocity. For a sky diver with an open parachute, the terminal velocity is typically about 5 m/s (11 mi/h).