4.2   CONSTANT SPEED

The case of the motion with a constant speed covers many more situations than the constant velocity case. An object moving at a **constant speed** covers equal distance in equal time regardless of the direction of motion. A motion with a constant speed may be a complicated three-dimensional motion. However, as long as the object covers the same distance in equal time, no matter how complicated the trajectory, the motion would have a constant speed. For instance, when a charged particle enters a region of non-zero magnetic field, the particle's direction of motion changes based on the charge and the magnetic field, but the speed of the particle remains constant as displayed for a positively charged particle between the poles of a magnet in Fig. 4.1.
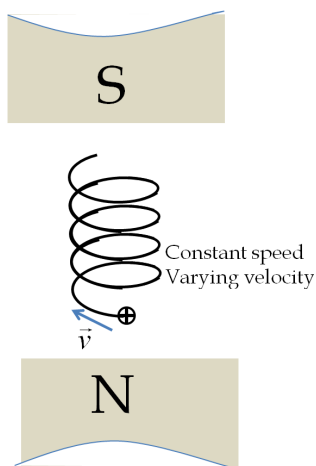
On the other hand, a motion with a constant velocity must always be a motion in a straight line since the direction for this type of motion is fixed in time.

Figure 4.1: A positively charged particle moves in a helical path in a uniform magnetic field with a constant speed but varying velocity.

Example 4.2.1. A runner runs on an oval 400-m long track at constant speed of 8 m/s. The first 100 m of the track is straight, but after that the track rounds a corner. (a) How far does the runner go in 20 sec? (b) What is the velocity of the runner at any instant during the 20 sec period?

Solution. (a) Since speed does not depend upon the direction, we can use Eq. 4.1 to find the distance.

$$s = v_s t = 8 \text{ m/s} \times 20 \text{ s} = 160 \text{ m}.$$

(b) The velocity requires both magnitude and direction. We know that the magnitude of velocity is constant and equals 8 m/s. But, the direction of the motion of the runner changes; the runner has one direction of velocity when he is in the straight part of the track but his direction of motion changes as he round the corner. Therefore, the velocity of the runner is actually changing. Since we do not have information about the direction of the track after 100 m we cannot assign one velocity for all instants in the duration of 20 sec. In the first 100/8 sec the velocity has the magnitude of 8 m/s and is pointed in the forward direction on the straight track.