4.1 CONSTANT VELOCITY

Constant velocity is perhaps the simplest motion. An object moving with a **constant velocity** with respect to a reference point has a constant speed and a constant direction. Let v_s be the constant speed. The distance s traveled in a duration t for a constant velocity object will be given by

$$\boxed{\text{Case: constant speed:}\quad s = v_s t.} \tag{4.1}$$

Since the direction of motion for a motion with constant velocity is fixed, we can choose one of the Cartesian axes to point in the direction of the constant velocity. This gives a simple one-component description of the velocity vector. Let $\vec{v}$ be the velocity vector and let the direction of motion be along the unit vector $\hat{u}_x$. The constant velocity vector can be written using the constant speed and the unit vector.

$$\boxed{\text{Case: constant velocity:}\quad \vec{v} = v_s \hat{u}_x.} \tag{4.2}$$

How would the position change with time? With this choice, the constant speed corresponds to the rate at which the x-coordinate changes with time.

$$\frac{dx}{dt} = v_s, \tag{4.3}$$

and the y and z-coordinates are fixed in time. The x-equation can be easily integrated to give the change in the x-coordinate during a duration t.

$$x - x_0 = v_s t, \tag{4.4}$$

where x is the x-coordinate at an arbitrary time t and x_0 is the x-coordinate of the particle at time $t = 0$.;

Example 4.1.1. Constant Velocity. A car is moving on an East-West road towards the East with a constant speed 30 m/s. If the car crosses a particular cross-section at $t = 0$, where will the car be 10 sec later?

Solution. Let the positive x-axis point in the direction of the constant velocity with the origin at the intersection. Then, the x-coordinate at an arbitrary time will be given by Eq. 4.4 with $x_0 = 0$.

$$x = v_s t = 30 \text{ m/s} \times 10 \text{ s} = 300 \text{ m}.$$

The car will be 300 m East of the intersection.