Lesson 1.5 – Rectilinear Motion

Rectilinear Motion is two-dimensional motion occurring along a straight line relative to a fixed origin on the line. Points on one side of the origin are assigned positive position, while the others are assigned negative position. The position is zero at the origin. Examples of rectilinear motion include a car driven along a straight track, and a ball thrown straight up into the air and allowed to fall back down. In the latter example, upward motion is usually considered positive.

We are typically concerned with the **position**, **velocity**, and **acceleration** of an object in rectilinear motion so that we may answer the following questions:

Where is the object at a given time?

$s(t)$ = **position** at time t relative to the origin

$|s(t)|$ = **distance from the origin** at time t (magnitude only, always positive)

How fast is the object moving at a given time?

$v(t)$ = **velocity** at time t (instantaneous rate of change of position)

$= s'(t)$ (slope of position curve)

$|v(t)|$ = **speed** at time t (magnitude only, always positive)

Is the object speeding up or slowing down at a given time?

$a(t)$ = **acceleration** at time t (instantaneous rate of change of velocity)

$= v'(t)$ (slope of velocity curve)

$= s''(t)$ (curvature of position curve)

What do the signs of velocity and acceleration tell us?

$v > 0, a > 0 \rightarrow$ moving in the positive direction and speeding up

$v > 0, a < 0 \rightarrow$ moving in the positive direction and slowing down

$v < 0, a > 0 \rightarrow$ moving in the negative direction and slowing down

$v < 0, a < 0 \rightarrow$ moving in the negative direction and speeding up

How far is the object from its initial position after a given interval of time?

$\int_{t_0}^{t_1} v(t)dt$ = **displacement** on $[t_0, t_1]$ (net signed area bounded by velocity)

$= s(t_1) - s(t_0)$ (change in position)

How much distance has the object accumulated over a given interval of time?

$\int_{t_0}^{t_1} |v(t)|dt$ = **total distance traveled** on $[t_0, t_1]$ (total area bounded by velocity)