RECTILINEAR MOTION – MOTION ALONG A LINE

As a particle moves along a coordinate line, it's coordinate s will vary as a function of time. This function, $s(t)$, is the **position function**.

The rate at which the particles coordinate changes with time is the **velocity** of the particle. $v(t) = s'(t) = \frac{ds}{dt}$

The rate at which the velocity changes with time is the **acceleration** of the particle.

$$a(t) = v'(t) = \frac{dv}{dt} \quad \text{or} \quad a(t) = s''(t) = \frac{d^2s}{dt^2}$$

Instantaneous speed is the absolute value of the velocity. The speed of a particle is always nonnegative; it tells how fast the particle is moving, but provides no information about the direction of motion

$$\begin{bmatrix}\text{instantaneous} \\ \text{speed}\end{bmatrix} = |v(t)| = |s'(t)| = \left|\frac{ds}{dt}\right|$$

A particle is ***speeding up*** when its instantaneous speed is increasing or when the velocity and acceleration have the same sign.

A particle is ***slowing down*** when its instantaneous speed is decreasing or when the velocity and acceleration have opposite signs.

Information from a Position versus Time Curve

- Where $s(t) > 0$, the particle is on the positive side of the origin on the line of motion.
- Where $s(t) < 0$, the particle is on the negative side of the origin on the line of motion.
- Where a tangent line has positive slope we have $v(t) = s'(t) > 0$, so the particle is moving in the positive direction along its line of motion.
- Where a tangent line has negative slope we have $v(t) = s'(t) < 0$, so the particle is moving in the negative direction along its line of motion.
- Where a tangent line is horizontal we have $v(t) = s'(t) = 0$, so the particle is momentarily stopped.
- Where the graph is concave up we have $a(t) = v'(t) = s''(t) > 0$, so the velocity is increasing.
- Where the graph is concave down we have $a(t) = v'(t) = s''(t) < 0$, so the velocity is decreasing.