

## Applied rates of change

### Velocity, speed, and acceleration

**Rectilinear motion** (motion of an object along a straight line):

**Position** is the location of an object and is given as a function of time. Conventional notation uses  $s(t)$ .

**Displacement** is the difference between the final position and the initial position...  $\text{displ} = s(t_f) - s(t_i)$ .

**Total distance traveled**... Sum of each distance between turns.

**Velocity** is the rate of change of position...  $v(t) = s'(t)$ .

**Average speed** over the interval  $[t_i, t]$  is  $\Delta s / \Delta t$ .

**Speed** is the absolute value of velocity...  $|v(t)|$

**Acceleration** is the rate of change of velocity ...  $a(t) = v'(t) = s''(t)$ .

# Key Observations

**Speeding up...** when velocity and acceleration have the same signs.

**Slowing down...** when velocity and acceleration have opposite signs.

**Advancing...** when velocity is positive.

**Retreating...** when velocity is negative.

**Accelerating...** when acceleration is positive.

**Decelerating...** when acceleration is negative.

In the following examples, assume rectilinear motion as described by  $s(t) = 4t^3 - 40t^2 + 50t + 2$  meters over the time interval [0 sec, 10 sec].

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**Example 1:** Find velocity, speed, and acceleration as functions of time. Label each with the correct units.

**Example 2:** Find the displacement of the object over the interval [0 sec, 10sec].

**Example 3: What is the total distance traveled?**

**Example 4:** Describe the motion of the object in terms of advancing and/or retreating.

**Example 5:** Describe when the object is accelerating and/or decelerating.