Speed is defined as the time rate that you are covering distance. **Velocity** is defined as the speed at which you are moving and the direction of the motion. 60 mph north is different than 60 mph east. In one dimension, the distinction between speed and velocity can be made by assigning one direction as positive velocity and the **opposite** direction as **negative**. If you move up at a velocity of 10m/s, then moving down at the same speed is equal to moving at a velocity of -10m/s.

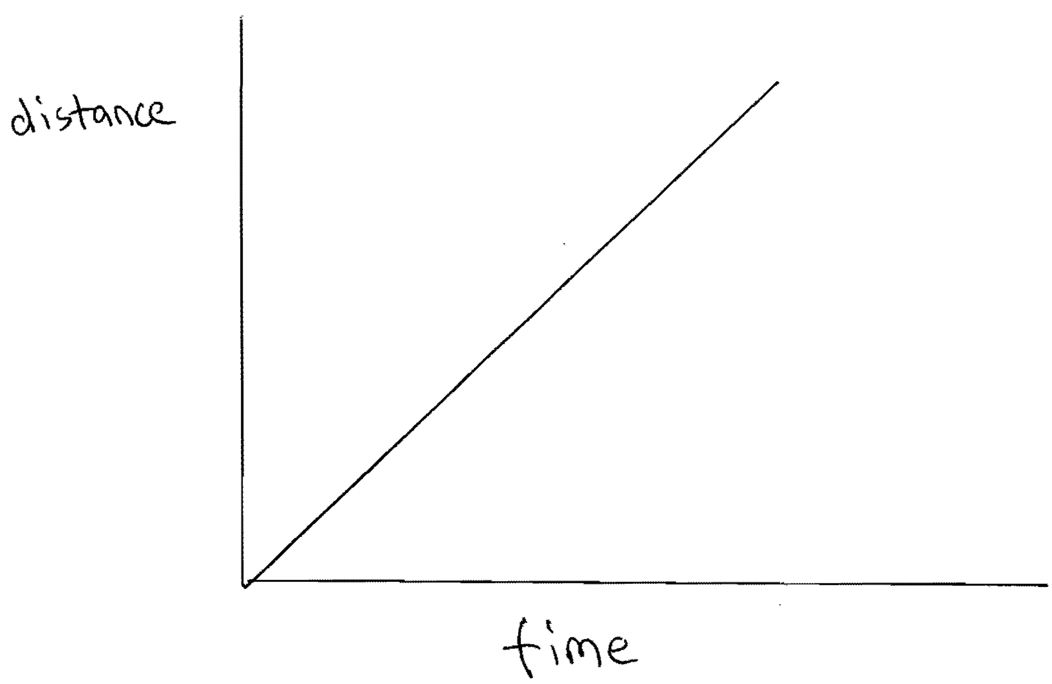
Instantaneous velocity is the velocity determined at a particular instant of time, such as observing your speedometer. Average velocity is a calculation describing the average motion over a finite interval of time.

(1) $v_{ave} = d/t$ thus,

(2) $d = v_{ave}\, t$

(3) $t = d/v_{ave}$

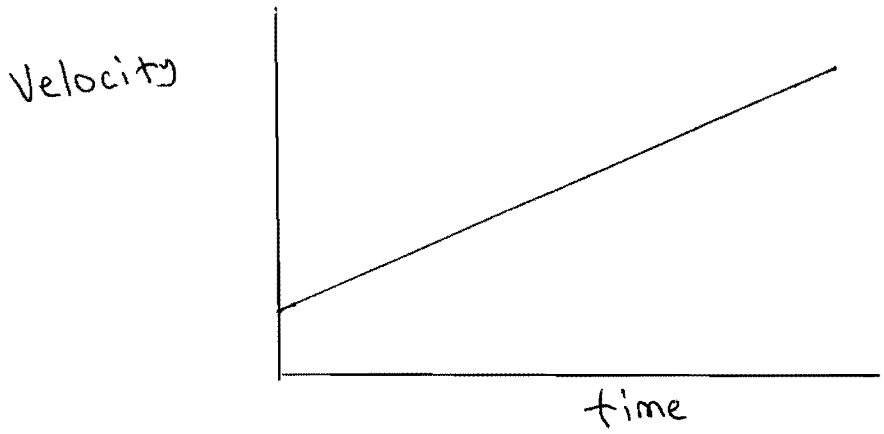
We can obtain an instantaneous velocity by graphing d (t). The slope represents the instantaneous value of the velocity. A straight line represents a constant velocity.



Average acceleration is the average time rate of change of the velocity. It is the difference between the velocity at the end of the time interval and the velocity at the beginning of the time interval, divided by the time between the two measurements.

(4) $a_{ave} = (v_f - v_i)/t = (v - v_0)/t$

Instantaneous acceleration is the time rate of change of a velocity at a particular instant of time. It can be derived from the slope of a v (t) graph. The vertical intercept of this graph yields the value of the initial velocity, v_0.



Comparing the straight line graph of velocity as a function of time with the generic straight line graph of y as a function of x yields:

$v = \mathbf{at} + \mathbf{v}_0$ and $y = \mathbf{mx} + \mathbf{b}$, thus, the slope is a and the intercept is v_0

where m is the generic slope and b is the generic intercept.

(5) $v = v_0 + at$ **constant a only!**

For a constant acceleration, the average velocity is equal to the final velocity plus the initial velocity divided by two.

(6) $v_{ave} = (v_0 + v)/2$ **constant a only!**

If we combine $v_{ave} = d/t = (v + v_0)/2$ with $v = v_0 + at$, the result is:

(7) $d = v_0 t + at^2/2$ **constant a only!**