1-Dimensional Motion of Objects

Quantities with Units of Length (m)

1.) Position

2.) Displacement

3.) Distance

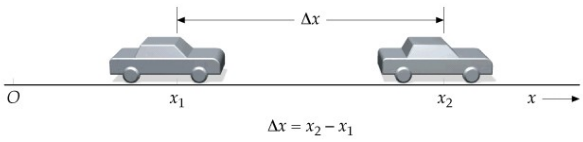
Position

Position **(*x*) is the separation between an object and a reference point. Position is a vector quantity and can be negative (behind the reference point) or positive (ahead of the reference point).**

Displacement

Displacement **(x_f -x_i) is the change in position of an object. Displacement is a vector quantity because an object can move both negatively (backwards) and positively (forwards) with respect to its initial position.**

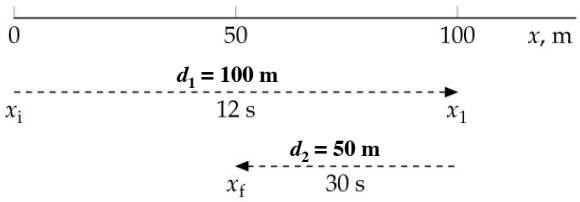
Displacement



Distance

Distance **is the *total path length* traversed in moving from one point to another. Distance is a scalar quantity and is always positive.**

Distance versus Displacememt



Distance is $d_1 + d_2 = 100\text{ m} + 50\text{ m} = 150\text{ m}$

Displacement is $\Delta x = x_f - x_i = 50\text{ m} - 0 = 50\text{ m}$

Quantities with Units of Length per Time (m/s)

1.) Velocity

2.) Speed

3.) Average Velocity and Average Speed

4.) Instantaneous Velocity

Velocity (m/s)

The *velocity* (*v*) of an object is a measure of the relative motion of the object with respect to a reference point.

Velocity is a vector quantity.

Speed (m/s)

The *speed* of an object is the magnitude of its velocity.

Speed is a scalar quantity.

Average Velocity (m/s)

The *average velocity* (v_{av}) is the displacement of an object, divided by the time interval during which the displacement occurs.

$$v_{av} = \frac{x_f - x_i}{t_f - t_i} = \frac{\Delta x}{\Delta t}$$

Average Speed (m/s)

The *average speed* is the distance an object travels, divided by the time interval.

$$\text{average speed} = \frac{\text{distance}}{\text{time}}$$

$$s = \frac{d}{\Delta t}$$

Instantaneous Velocity (m/s)

The *instantaneous velocity* (v) is the velocity of an object at a specific instant of time.

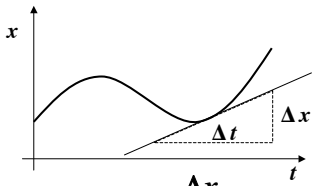
$$v = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t}$$

Instantaneous Velocity (m/s)

The *instantaneous velocity* can be found from *a graph of position versus time*. It is equal to the slope of the tangent to the curve at a particular instant of time.

Position versus Time Profiles

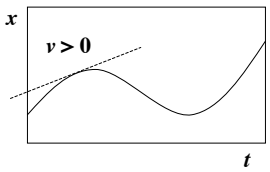
The slope of the tangent to the curve at a particular instant of time of a position-time profile gives the instantaneous velocity.



$$\text{slope} = \frac{\Delta x}{\Delta t} = v$$

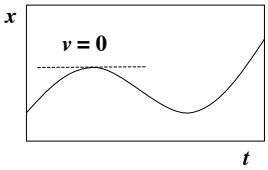
Position versus Time Profiles

The slope of a position-time profile gives the instantaneous velocity.



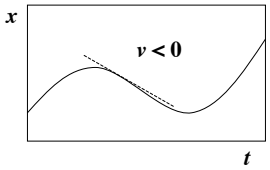
Position versus Time Profiles

The slope of a position-time profile gives the instantaneous velocity.



Position versus Time Profiles

The slope of a position-time profile gives the instantaneous velocity.



Equation of Motion for Constant Velocity

The change in position of an object can also be described with the following equation:

$$v = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i} \quad \text{or} \quad \boxed{\Delta x = v\Delta t}$$

$$x_f - x_i = v(t_f - t_i)$$

$$\boxed{x_f = v\left(t_f - t_i\right) + x_i}$$

Velocity versus Time Profiles

The area under a velocity-time graph gives the displacement during that time period.